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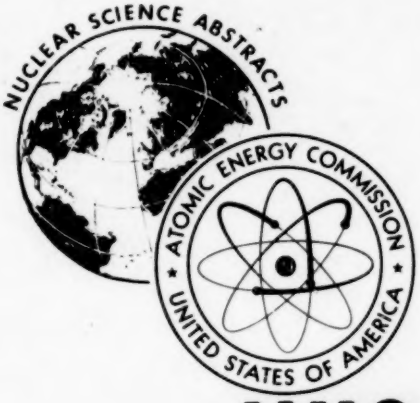

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The categories and subcategories for abstracts have been redefined and the definitions are included in Appendix II in this issue. As a matter of future practice, category definitions will appear in *NSA* twice annually in issues 1 and 13.

The list of journals scanned regularly for *NSA*, as of this issue, is contained in Appendix III.

Volume 18, Number 1, January 15, 1964

NUCLEAR SCIENCE ABSTRACTS

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Volume 18, Number 1 January 15, 1964

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

1 (CONF-245-2) EXPERIMENTAL USEFULNESS OF THE KANGAROO RAT. Thomas J. Haley (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [Sept. 13, 1963]. Contract AT(04-1)-Gen-12. 17p.

From Animal Care Panel 14th Annual Meeting, Los Angeles, Oct. 1963.

The kangaroo rat is readily tamed and has certain characteristics that make it unique and of interest in highly specialized research programs. Studies were conducted on its ability to exist on a dried diet with only a bare minimum of water and that obtained from succulent plants. Hematological studies indicate that the kangaroo rat exhibits a different hematological distribution of cells than the mouse or rat. The lymphocyte constitutes 81.4% of the total leukocytes. The hematocrit has a value of 46 to 48 in spite of the high degree of water conservation practiced by the animal. The response to ionizing radiation of this species does not differ from that reported for the mouse or rat. Behavior studies indicate that the digging characteristics of the kangaroo rat are similar to those of the gerbil. Furthermore, the animal shows definite psychotic tendencies under the influence of psychotomimetics like LSD-25 and psilocybin. An evaluation of the physiological responses of isolated tissues from this animal as well as its responses to anesthetics is being undertaken to evaluate its further usefulness in the laboratory. (auth)

2 (TID-19599) A METHOD FOR CLUSTER ANALYSIS. A. W. F. Edwards and L. L. Cavalli-Sforza (Pavia, Italy. Università. Istituto di Genetica). [1962]. Contract AT(30-1)-2280. 23p.

A method for investigating the relation of points in multidimensional space is described. Using an analysis of variance technique, the points are divided into the two most-compact clusters, and the process repeated sequentially so that a tree diagram is formed. It is pointed out that the method is well suited to electronic computing. The application of the method to problems of classification is stressed, and numerical examples are given of applications in the analysis of chromosome patterns in cells. (C.H.)

3 (TID-19618(App.D)) THREE METHODS OF ANALYZING BRANCH DATA. Russell J. Nutnik (Tennessee. Univ., Knoxville). 10p.

Procedures are described for analyzing data on the volume and weight of tree branches. All branch weight and volume calculations were done on a sample tree basis. (C.H.)

4 SELFER MUTANTS OF SALMONELLA TYPHIMURIUM. M. Demerec (Brookhaven National Lab., Upton, N. Y.). Genetics, 48: 1519-31(Nov. 1963). (BNL-7126)

The name selfer has been given to a mutant strain of bacteria in which transduction with homologous phage gives rise to a significantly larger number of wild-type variants than occurs by spontaneous reversion in uninfected control bacteria. Experiments with 201 auxotrophic mutants of Salmonella typhimurium representing 22 gene loci carried in 12 transducing fragments showed that about 40% of these mutants are selfers. In similar experiments with 32 auxotrophs representing four histidine loci, one selfer has been detected. A statistical analysis has revealed that selfer mutations are not distributed at random either within or among the loci where they are known to occur. The frequency of wild-type variants in selfing is evidently connected in some way with the transduction process. The excess variants cannot be transductants, however, since they appear also in crosses between selfer recipients and donors that carry a deletion covering the selfer gene. It is proposed that they are revertants: that the presence of a transducing fragment in the proximity of a selfer gene, when the fragment synapses with the homologous region of the bacterial chromosome, stimulates the gene's mutability. (auth)

5 MEDICAL RESEARCH WITH HIGH-ENERGY HEAVY PARTICLES. Giulio J. D'Angio and John H. Lawrence (Univ. of California, Berkeley). Nucleonics, 21: No. 11, 56-61(Nov. 1963).

Radiobiological and medical research using neutrons and larger nuclear fragments is discussed. Seventy references are given. (R.E.U.)

6 ACTION OF THE INGESTION OF X-IRRADIATED COLI BACCILI ON TUMOR DEVELOPMENT IN MICE BEARING CANCER GRAFTS. A. Compton (St. Mary's Hospital, London). Presse Med., 70: 1807-8 (Sept. 22, 1962). (In French)

To follow up previous experiments using irradiated animal tissue, several experiments were conducted on the effect of ingestion of irradiated Escherichia coli on mice with grafted cancers. In the first experiment 10 pure-bred gray mice were grafted with tumor 22 (Compton), an adenocarcinoma, with an average weight of 24 mg. Five of the mice were subsequently fed an x-irradiated (15,000-30,000 r) E. coli culture. The second experiment was made on 9 similar mice, 5 of which were treated with an

irradiated (15,000-50,000 r) culture. In this experiment, treatment was continued for 27 days, as compared with 16 days in the first experiment. In both studies, 100% of the tumors progressively increased in weight in control, untreated animals. In the first experiment 60% of the mice fed irradiated bacteria showed retardation of tumor growth, and in the second experiment, 60-80%. Although these experiments were on a small scale, their validity is supported by the following facts: the strain of mice used showed absolutely no resistance to the cancer grafts; large grafts were used to produce significant tumors; both experiments produced the same results. It is suggested that future studies investigate: greater possible effectiveness of other bacteria; determination of optimum irradiation dose for their protective effect; more effective means of introducing irradiated substance; isolation of the tumor-inhibiting factor. (BBB)

7 THE CONTROL OF BRISTLE PATTERN BY HAIRY-WING IN DROSOPHILA MELANOGASTER. Frederick Jay Gottlieb. Thesis, Berkeley, Calif., Univ. of California, 1962. 61p.

An analysis of the control of developmental patterns exercised by the mutant gene Hairy-wing 49c (to be referred to as Hairy-wing) in Drosophila melanogaster was undertaken. This gene, in addition to causing the formation of chaetae on the wing veins, controls the formation of extra macro- and microchaetae on the thorax. By means of genetic mosaics, produced by inducing somatic crossing-over in heterozygous larvae with x irradiation, a developmental analysis of the differences in differentiation in the tissues of the Hairy-wing homozygous genotypes was performed. Two of the mosaic classes, categorized on the basis of the position of the mosaic patches with respect to the dorsocentral region, which had been expected to occur in equal frequencies, were found in numbers which differed significantly from equality. It is postulated that there is an alteration of the position of the centers of the fields of developmental organization by homozygous Hairy-wing tissue, due to its high chaetogenic activity. X irradiation causes Hairy-wing heterozygotes to express themselves in a homozygous-like fashion. Interactions were observed between the 3 different genotypes in mosaics. Hairy-wing homozygous tissue acts semi-autonomously in mosaics. Tissue, homozygous for the wild type gene for Hairy-wing, acts non-autonomously and will occasionally produce extra macrochaetae in the presence of adjacent homozygous and, more rarely, heterozygous Hairy-wing tissue. (M.P.G.)

Ecology

Refer also to abstract 462.

8 (TID-19498) ION INTERACTIONS IN PLANT TISSUES. Progress Report, January 1963–January 1964. Fred H. Emmert (Connecticut. Agricultural Experiment Station, Storrs). Contract AT(30-1)-2117. 12p.

Progress is reported in a study of nutrient ion uptake by plants from soil and ion interactions in plant tissues. Data are included from investigations on water utilization and Sr discrimination by plants and ion penetration of plant roots. Strontium-89, Ca^{45}, and P^{32} were used as tracers in these studies. (C.H.)

9 (TID-19618) VEGETATION STUDIES RELATED TO MOVEMENT OF RADIOACTIVE WASTES. Complete Scientific Report, September 1963. Edward E. C. Clebsch and H. R. DeSelm (Tennessee. Univ., Knoxville). Contract AT(40-1)-2077. 226p.

Separate abstracts were prepared on 6 sections of this report. One section (Appendix C) was previously abstracted and appeared in NSA. (C.H.)

For abstracts of individual sections see: 3, 10, 11, 12, 171, and 419.

10 (TID-19618(p.5-37)) MINERAL CYCLING ON A SITE CONTAMINATED WITH RADIOACTIVE WASTE PRODUCTS—WHITE OAK LAKE BED, OAK RIDGE, TENNESSEE. Final Report. H. R. DeSelm (Tennessee. Univ., Knoxville).

Data relevant to the dispersal of radioactive waste were collected as the result of studies of the bed of the former White Oak Lake, Oak Ridge, Tennessee. White Oak Lake served as a depository for low-level radioactive wastes from 1943 to 1955, when it was drained. Data are presented on biotic invasion, the chemical content of natural vegetation, site factors influencing plant chemical content, and the cycling of certain elements in the lake bed ecosystem. Emphasis was placed on the movement of K, Ca, Mg, Cs^{137}, Cs^{60}, Sr^{90}, Ru^{106}, Zr^{95}, Nb^{95}, and Ce^{144}. The cycling of materials through the ecosystems dominated by herbaceous taxa is discussed from the standpoint of amount of material moved per year, proportion of available material moved per year, and number of years required to return to the soil one year's input. Using the vegetation-sampling data, chemical concentrations, and litter accumulation data, a predictive equation was derived regarding rate of accumulation and movement of certain elements through soil-vegetation-litter systems. Calculated equilibrium figures approximate those of mesic and moist forests of the area. (C.H.)

11 (TID-19618(p.38-112)) MINERAL CYCLING IN REGIONAL ECOSYSTEMS. (Tennessee. Univ., Knoxville).

Sampling methods are described for use in the estimation of total organic matter and the mineral pool in regional ecosystems. A program of field and laboratory studies was carried out in the Balsam Mountains of western North Carolina and in eastern Tennessee. Detailed studies were made of leaf, branch, and bole volumes, mass, and mineral content of vegetation. Data from field and laboratory samples were subjected to machine computations using a flexible computer program. Data are presented in tabular form. Data on production and energy flow in forest ecosystems and forest mensuration were derived from resul of mineral cycling studies. Results are included from studies on the production, accumulation, and breakdown of litter and humus; and the distribution and natural redistribution of atmospheric washout and fallout materials, with special reference to radioactive contaminants. (C.H.)

12 (TID-19618(App.A) PLANT TAXA ON A THREE ACRE PORTION OF WHITE OAK LAKE BED, OAK RIDGE, TENNESSEE, 1956-1960. (Tennessee. Univ., Knoxville). 7p.

A list of plants found on a 3-acre portion of the drained White Oak Lake bed between 1956 and 1960 is presented. (C.H.)

13 MITES ON KANGAROO RATS AT THE NEVADA TEST SITE. Morris A. Goates. Brigham Young Univ. Sci. Bull., Biol. Ser., 3: No. 4, 1-12(Oct. 1963).

A systematic study of parasitic mites on kangaroo rats of two species at the Nevada Test Site was conducted from August 1959 to December 1961. The intent was to determine the kinds, numbers, seasonal occurrences, and ecological relations of mites in nuclear disturbed and contiguous undisturbed areas. A total of 1,256 rats from nine plant communities was examined. Data are summarized. (C.H.)

Metabolism, Tissue Distribution, and Toxicology

14 (EUR-368.d) KATIONISCHE RADIONUKLIDE UND IHRE DEKORPORIERBARKEIT. (Cationic Radionuclides and their Decorporability). W. H. Mueller (European Atomic Energy Community). 1963. 16p.

The paths by which radioisotopes enter animals and factors influencing their toxic effects are reviewed. Emphasis is placed on the uptake and distribution of Sr^{90} and other cationic radionuclides. The physical and chemical properties of chelating agents and cationic radionuclides are summarized. The effectiveness of chelating agents in removing radioisotopes from animals is discussed. Data are presented on the effectiveness of EDTA and DTPA in the removal of radioactive isotopes of the alkaline earths Sr, Ba, and Ra. Data on the effectiveness of these compounds in the removal of radioactive metals from rats are included. (C.H.)

15 (HW-SA-3141) THYROIDAL RADIOIODINE CONCENTRATIONS IN NORTH AMERICAN DEER FOLLOWING 1961–1963 NUCLEAR WEAPONS TESTS. W. C. Hanson, A. H. Dahl, F. W. Whicker, W. M. Longhurst, V. Flyger, S. P. Davey, and K. R. Greer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash. and Colorado State Univ., Fort Collins). [Aug. 2, 1963]. Contract AT(45-1)-1350. 10p. (CONF-66-11)

From Symposium on the Biology of Radioiodine, Richland, Wash., June 1963.

Radioiodine concentrations were measured in deer, elk, caribou, and reindeer thyroids collected in Alaska, California, Colorado, Maryland, Washington, and Wyoming during the period September 1961 through mid-April 1963. Periods of maximum I^{131} concentrations in most samples occurred in winter months, about two to three months after initial atmospheric tests. Values during the 1961 peak period were slightly greater than during the 1962 peak period but were maintained over a shorter period of time. The I^{131} concentrations showed a clear response to each series of nuclear tests conducted by France, Russia, and the U. S. Maximum response occurred following tests conducted in the atmosphere and the SEDAN detonation on July 6, 1962; least response followed underground tests. Thyroid doses received by the various animal groups from I^{131} during the 1962 and 1963 nuclear tests varied from about 20 rads in Colorado deer to 0.8 rad in Alaskan reindeer, compared to 5.1 and 1.2 rads, respectively, in similar samples collected during the 1961 and 1962 nuclear test series. (auth)

16 (TID-19472) [RADIOACTIVITY IN MARINE ENVIRONMENTS]. First Progress Report. Bruno Schreiber (Parma, Italy. Università). [1963]. Contract IAEA 62/US. 20p.

Data are presented on the content of Sr^{90} in plankton and other marine biological materials collected at various depths in the Ligurian and Adriatic Seas during 1961, 1962, and part of 1963. Preliminary results are included from an ecological study of Acantharia in the Atlantic Ocean. (C.H.)

17 (JPRS-21511) TOXICOLOGY OF CERTAIN RADIOACTIVE SUBSTANCES. A. A. Rubanovskaya. Translated from Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, 160-73(1962). 20p. (OTS-63-31967)

Separate abstracts were prepared for translations of two articles from the Russian language publication Material on the Toxicology of Radioactive Substances. (C.H.)

For abstracts of individual papers see: 18 and 19.

18 (JPRS-21511(p.1-13)) COMPOUNDS USED IN THE ELIMINATION OF RADIOACTIVE SUBSTANCES IN THE ORGANISM. A. A. Rubanovskaya. Translated from Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, 160-9(1962).

Studies with rats showed that the CaN_2 salts of diaminocyclohexanetetraacetic acid (DCTA) decreases deposition and accelerates elimination of injected or ingested Fe^{59}. The compound is most effective when administered soon after the intake of Fe^{59}. Pectin decreased the gastrointestinal absorption of Fe^{59} given orally. CaN_2 DCTA was shown to be as effective as CaN_2 EDTA in accelerating the elimination of Fe^{59} by rats. (C.H.)

19 (JPRS-21511(p.14-19)) POLYVINYL PYRROLIDONE IN AFFECTIONS WITH CERTAIN RADIOACTIVE ISOTOPES. A. A. Rubanovskaya. Translated from Materialy po Toksikol. Radioaktivn. Veshchestv, Inst. Gigieny Truda i Profzabolevanii Akad. Med. Nauk SSSR, 170-3(1962).

Polyvinyl pyrrolidone-100 (PVP with molecular weight of 10,000 to 20,000) decreased the gastrointestinal absorption and deposition of Sr^{90} in rats when introduced into the stomach immediately before the Sr^{90} was given by mouth. Polyvinyl pyrrolidone did not increase the effectiveness of diaminocyclohexanetetraacetic acid in accelerating the elimination of Fe^{59} from rats. (C.H.)

20 STUDIES OF THE METABOLISM OF Mn^{54} IN SOME ENDOCRINE AND REPRODUCTIVE ORGANS IN THE FEMALE MOUSE. Sven Erik Englund (Karolinska Institutet, Stockholm). Acta Obstet. Gynecol. Scand., 39: 575-85(1960).

In adult mice injected subcutaneously with $Mn^{54}Cl_2$ the reproductive and endocrine organs and the hemispheres of the cerebrum were examined regarding the Mn concentration, exchangeable Mn, biological half life, turnover rate, and metabolized amount (Mn/g/day). Manganese was found to reach a very high concentration and to have a short biological half life in the thyroid compared with the other endocrine and reproductive organs examined. The cerebral hemispheres showed a low concentration and a long biological half life. The concentration of Mn was about equal in all the reproductive organs studied, but was slightly higher in the corpus uteri and the tubes than in the cervix and vagina. The metabolism of Mn did not vary to any large extent among these organs, but they showed considerable differences from the cerebrum. (BBB)

21 AN OPERATED CASE OF ENCHONDROMA TIBIAE IN WHICH THE COURSE OF HEALING WAS FOLLOWED WITH Sr^{85}. Ragnar Magnusson and C.-O. Oldfelt (Central Hospital, Linköping, Sweden). Acta Orthopaed. Scand., 32: 290-7(1962).

Sr metabolism in bone was investigated in a 66-yr-old man from whom a large tibial chondroma had been removed and the defect filled with bone chips. Injection of Sr^{85} was used to follow the processes of new bone formation and bone regeneration during the period of healing. In order to follow the course of healing from all aspects and to be able to verify any possible recurrence, histologic and radiologic examinations were also made. Doses of ~30 μC Sr^{85} were injected on 7 different occasions. Nine months after surgery it was then found that a few of the implanted chips were loose, but no macroscopic tissue reaction could be found around them. On tomography 14

months after the operation, some areas of rarefaction were found in the bone. On counting, moreover, an increased activity was found within these areas, which indicated an active process, so that the recurrence of tumor was considered to have occurred, but no macroscopic signs of recurrence were found. The biological half life of Sr^{85} varied from 39 days early after injections were begun to 55 days at a later period. These values of the biological half life are an expression of the speed with which the radioactivity disappeared from each counting point over the healthy and diseased tibiae. They have no general significance but do allow a comparison to be made between various periods of time for precisely that point at which they were counted. A test with Sr^{85} 3¾ yr after the operation, indicating a considerably higher quantity of Sr^{85} uptake in the operated leg than in the healthy leg, showed that the increased speed of bone renewal still existed on the side treated even after this long period. The presence of radioactivity in united chips and in loose chips suggests that the chips have undergone regeneration and reformed into bone specific to the body. (BBB)

22 TOXICOLOGY: RADIOACTIVE METALS. A. Catsch (Kernforschungszentrum, Karlsruhe, Ger.). Ann. Rev. Pharmacol., 3: 243-66(1963).

The survey covers 171 articles published in 1960 and 1961. It is concluded from the survey that screening investigations on distribution and excretion patterns of radiometals can be regarded as completed now that the rarer and less important elements have been included. In summarizing this work it proved impossible to classify radiometals by their metabolic behavior as related to their chemical qualities and their place in the periodic system. Such analyses revealed only a limited correlation. Although analogies between the metabolism of elements in certain main groups (e.g., alkaline metals, alkaline earths, or lanthanides) are known, these, however, were not found for elements of other groups or subgroups. In view of the relatively numerous exceptions, a tentative attempt to correlate the metabolic behavior of radiometals to their valency was unsatisfactory. To date, the LD_{50} has been determined for most of the practically important radiometals, and the qualitative aspects of radiotoxicity have been treated exhaustively. Toxicological studies will probably now shift toward investigations in which the practically encountered types of incorporation (continuous ingestion or inhalation) occur, as well as the quantitative elucidation of long-term effects. Of special interest is the question of dose relation and of a threshold dose. Whereas formerly, often tacitly, the assumption was made that the metabolic behavior of internally deposited radiometals is independent of the radioactivity level over a wide range, more recent investigations have shown that this is not necessarily true. Especially in the skeleton, deposition of toxic amounts of radioactivity seems to impair elimination processes. Data relating in individual metals are reviewed. (BBB)

23 STRONTIUM RICKETS: BONE, CALCIUM, AND STRONTIUM CHANGES. E. Storey (Univ. of Melbourne). Australian Ann. Med., 10: 213-22(Aug. 1961).

In rats fed increasing Sr levels in the diet, inhibition of calcification occurred as seen by increased width of epiphyseal cartilage, presence of uncalcified bone matrix, and decreased ash weight of bone. With ash weight as an indicator of mineralization, inhibition of calcification became greater as the dietary Sr level increased. This inhibition was maximum when the Ca/Sr molar ratio in serum became <10/1. In contrast to ash weight, the percentage ash in bone was a less sensitive indicator of rachitic change, because both mineral and organic weight decreased proportionately, and consequently the percentage ash remained unchanged until high dietary levels of Sr were reached. Incorporation of Sr into bone varied, not with dietary Sr levels, but with the Ca/Sr ratio. The two ions were treated similarly, for the decrease in Ca/Sr ratio in the bone was proportional to that in diet for both young and old rats. In growing animals, addition of new bone mineral was probably the most important mechanism whereby Sr became incorporated into ash, while in slowly growing rats ion exchange assumed a more important role. At low dietary levels of Sr, bone matrix formation decreased roughly proportionately to inhibition of calcification, but at higher levels uncalcified bone matrix became prominent. These results may be of significance to the problem of osteoporosis, for they demonstrate that disorder of calcification can be associated with decreased growth of bone matrix. This suggests that osteomalacic and antianabolic mechanisms are not mutually exclusive, but may be interrelated factors in the pathogenesis of osteoporosis. (BBB)

24 DECOUPLING OF PROTEIN AND RNA SYNTHESIS DURING DEUTERIUM PARTHENOGENESIS IN SEA URCHIN EGGS. Paul R. Gross, William Spindel, and Gilles H. Cousineau (Brown Univ., Providence; Rutgers State Univ., Newark, N. J.; and Marine Biological Lab., Woods Hole, Mass.). Biochem. Biophys. Res. Commun., 13: 405-10(Oct. 29, 1963).

The parthenogenetic activation of cell division and suppression of nucleic acid synthesis by deuterium in eggs of sea urchins was investigated. D_2O treatment was found to evoke a high rate of protein synthesis in the eggs that was maintained for several hours. However, eggs whose protein synthesis was activated and that were making labeled cytasters showed no increment in RNA synthesis over controls. (P.C.H.)

25 METABOLISM OF Sr^{85} AND Ca^{45} IN MAN AFTER SINGLE AND MULTIPLE DOSES. Joseph Samachson (Veterans Administration Hospital, Hines, Ill.). J. Appl. Physiol., 18: 824-8(July 1963).

The metabolism of Sr^{85} was investigated in humans to provide data to aid in predicting body retention of Sr^{90}. Studies were carried out on three women, two of which were on a low-Ca intake of ~150 mg/day, while the third patient had a dietary supplement of Ca gluconate tablets, to give a Ca intake of about 1500 mg/day. All three received single doses of Sr^{85}, and one Ca^{45} as well, the plasma levels, and urinary and fecal excretions being followed for 3 to 4 weeks. Calculations were made to predict plasma levels and excretions following the administration of 12 small doses of isotopes to each patient, and values predicted were compared with those found. Changes in Ca metabolism limited the predictive value of single-dose data, but when variations in urinary Ca could be allowed for, predicted and found values agreed well. After a discussion of the factors involved in extrapolation from single to multiple doses, it was concluded that, within certain limitations, the extrapolation is valid and applicable to the problems involved in the investigation of Sr^{90} as well. However, the fact that Sr^{90} may be ingested over a long period of time makes comparison with single-dose data less valid. Although the excretion and retention of Ca^{45} and Sr^{85} are additive, their biological effects may not be, and it may make considerable difference whether a dose is given as a single portion or subdivided into many. Thus, frequent exposure to small doses of radioactivity may either sensitize to later doses or have the opposite effect by giving irradiated tissues time to recover. (BBB)

26 INTERMITTENT BONE CHANGES AND MULTIPLE CARTILAGE DEFECTS IN CHRONIC STRONTIUM RICKETS IN RATS. E. Storey (Univ. of Melbourne). J. Bone Joint Surg., 44B: 194-208(Feb. 1962).

Young (3-week-old) and adult rats were fed a stock diet containing 1.5% Ca, 1.8% Sr, and 0.90% P. Continuous Sr feeding first induced typical rickets in young rats receiving adequate Ca, P, and vitamin D but later the widened cartilage spontaneously calcified intermittently leaving transverse bands consisting largely of osteoid tissue in the metaphysis; in addition to intermittent calcification, bone changes indicated that skeletal growth was not uniformly progressive. Subsequently areas of the epiphyseal cartilage failed to calcify and localized defects developed; among these are wedge-shaped metaphyseal osteoid tissue masses, invagination of the epiphyseal plate to form multiple nodules of cartilage with proliferating cells in the middle and hypertrophic ones at the periphery, perforation, and fragmentation of the epiphyseal plate with formation of large cartilage nodules. Multiple cartilage nodules of different sizes appeared in the epiphysis, metaphysis, and bone shaft. Most bone margins were lined by osteoid seams which only slowly calcified and concomitantly resorption was decreased so that the rate of remodeling of the skeleton was diminished. This process may help to explain the results of treatment of osteoporosis by Sr administration. (BBB)

27 INEXPENSIVE TECHNIQUE FOR PRODUCTION OF C^{14} ALFALFA FOR ANIMAL FEEDING EXPERIMENTS. C. L. Keith, E. E. Bartley, E. L. Sorensen, L. R. Fina, and D. W. Stanton (Kansas State Univ., Manhattan). J. Dairy Sci., 46: 745-8(July 1963).

For preparing C^{14}-labeled alfalfa, for use as a tracer in rumen metabolism studies, a special growth chamber, in which $C^{14}O_2$ of high specific activity was utilized in the photosynthetic process, is described and illustrated. The growth chamber was constructed of $\frac{3}{8}$-in. clear Plexiglas held together by brass machine screws at 2-in. intervals. The Plexiglas edges were softened with ethylene dichloride before being fastened to form air-tight joints, and all seams were calked on the inside with a nonhardening calking compound as a precaution against leakage. A dehumidifier was placed in the chamber and water condensed by it was recirculated to the plants by an electric vertical immersion pump. Pressure changes within the chamber due to temperature and barometric fluctuations were absorbed by a spirometer. An air conditioner was positioned to blow into a canopy covering the chamber. Total cost of the chamber was ~$400, including labor, all parts, accessories, and dehumidifier but excluding an air conditioner. A measured amount of $BaC^{14}O_3$ was used as a source of $C^{14}O_2$, which was generated by introduction of 85% phosphoric acid into a tube containing the carbonate. The quantities of C^{14} used which was recovered in the dry wt of the total plant averaged 33.8%. The greatest recovery of C^{14} was in the healthiest and most vigorously growing plants. The percentage of C^{14} recovered in plant material was similar, whether all the $C^{14}O_2$ was released at periodic intervals during growth or only once. The chamber can also be used for labeling other plants in either soil or hydroponic culture. (BBB)

28 EFFECT OF METAL IONS ON THE RELATIVE UPTAKE OF Ca^{45} AND Sr^{85} BY BONE POWDER IN VITRO. J. Samachson and H. Lederer (Veterans Administration Hospital, Hines, Ill. and Montefiore Hospital, New York). J. Dental Res., 41: 1340-8(Nov.-Dec. 1962).

The ratio of uptake of Ca^{45} to that of Sr^{85} by defatted bone powder in vitro was used as a parameter for the study of bone surfaces. To test the hypothesis that one difference between sites where ions exchange was the space available on the crystal surface, defatted bone powder was treated with metallic ions of different radii and then shaken with solutions containing Sr^{85} and Ca^{45}. Alternatively, the metal ions were added to the same solution as the radioisotopes. Uptake was determined both with defatted bone powder and with anorganic bone. The ratio of Ca^{45}/Sr^{85} uptake was decreased by Be^{2+}, Cu^{2+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Cd^{2+}, Zn^{2+}, and Pb^{2+}, unaffected by Mg^{2+}, and increased by Ba^{2+}. Other factors also influenced the ratio, but, in general, the hypothesis suggested above appeared valid. Reproducibility of individual uptake values, but not of the ratio, was increased by more vigorous shaking. (auth)

29 PERMEABILITY OF SQUID AXON MEMBRANE TO VARIOUS IONS. Ichiji Tasaki (National Inst. of Mental Health, Bethesda, Md.). J. Gen. Physiol., 46: 755-72(Mar. 1963).

The permeability of the squid axon membrane to Na^{22}, Na^{24}, K^{42}, Cl^{36}, Ca^{45}, Br^{82}, Rb^{86}, Cs^{134}, and Cs^{137} was determined. Effluxes of these isotopes were measured mainly by the method of intracellular injection. Measurements of influxes were carried out under continuous intracellular perfusion with an isotonic solution of potassium sulfate. The Na^{24} permeability of the resting (excitable) axonal membrane was found to be roughly equal to the K^{42} permeability. The permeability to anions was far smaller than that to cations. The Na^{24} influx was 12 to 20 cpm in 5 min for a level of radioactivity of 1000 cpm/μl in the medium. The K^{42} influx in 5 min was 8 to 15 cpm when the level of radioactivity in the medium was 1000 cpm/μl. Influx of radiocesium varied directly with the level of radioactivity of the medium. There was no significant difference between the two radioisotopes of Cs ion. The influx in 5 min was 6 to 10 cpm for a level of 1000 cpm/μl in the medium, which is ~$\frac{1}{2}$ of the corresponding value for Na^{24}. The influx of Rb^{86} in 5 min was 15 to 18 cpm for 1000 cpm/μl in the medium. This value was not significantly different from the values for Na^{24} and K^{42}. The influx of Br^{82} was ~$\frac{1}{20}$ the value for K^{42} and Na^{24}, or 1 to 3 cpm in 5 min for 1000 cpm/μl in the medium. The influx of Ca^{45} was 3 to 6 cpm in 5 min for 1000 cpm/μl in the medium. This value is significantly smaller than the corresponding values for univalent cationic tracers. It is emphasized that the axonal membrane has properties of a cation exchanger. The physicochemical nature of the two stable states of the excitable membrane is discussed on the basis of ion-exchange isotherms. (BBB)

30 INFLUENCE OF LACTATION ON THE RETENTION OF A SINGLE DOSE OF STRONTIUM-90 IN RATS. W. E. Kollmer and H. Kriegel (Heiligenberg-Institut, Ger.). Nature, 200: 187-8(Oct. 12, 1963).

Strontium-90 was injected in female mice within the day after delivery. The experiment was arranged so as to allow the estimate of net removal of Sr^{90} from bone during a three day period by comparing radioactivity of the femora at 3 and 21 days after injection of the isotope. Retention of Sr^{90} in the skeleton of the controls (virgin rats) was 49% of the injected dose (retention of skeleton = retention of femur × 20) 3 days after injection. At the same time, the nursing animals retained 4.16% of the injected dose. Twenty-one days after the injection the radioactivities were 35% of the injected dose for virgin rats and 20.8% for nursing rats. The results demonstrate a considerable capacity of nursing rats to mobilize radiostrontium from their skeleton later than 3 days after injection of the isotope. (P.C.H.)

31 BIOLOGICAL HALF-LIFE OF CAESIUM IN MAN IN ACUTE AND CHRONIC EXPOSURE. J. Rundo, Judith I. Mason, D. Newton, and B. T. Taylor (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 200: 188-9(Oct. 12, 1963).

The hypothesis that the body content during chronic exposure may be predicted by mathematical integration with respect to time of the equation describing the retention following a single acute intake is discussed. Experiments were made to demonstrate the essential correctness of the assumption for radioisotopes of Cs. Data from acute exposure and body content and mean daily excretion of fallout Cs are tabulated. (P.C.H.)

32 MANGANESE-54 AND ZINC-65 IN COASTAL ORGANISMS OF CALIFORNIA. T. R. Folsom, D. R. Young, J. N. Johnson, and K. C. Pillai (Scripps Institution of Oceanography, La Jolla, Calif.). Nature, 200: 327-9 (Oct. 26, 1963).

Marine organisms off the coast of southern California were analyzed for Mn^{54} and Zn^{65}. The results indicate that certain dinoflagellates and other organisms from the same coastal waters can concentrate Mn^{54} several thousand fold. Mussels and barnacles appear to concentrate Mn^{54} more than Zn^{65}, whereas the fish do the opposite. Surface fish contain distinctly more of both metals than do the deep-living hagfish. It was also evident that some surface fish can concentrate Zn^{65} by three orders of magnitude. Data are tabulated. (P.C.H.)

33 STUDIES ON Ca^{45} TURNOVER RATE IN BLOOD FOR OLD AGED. Kunio Owada and Noboru Oshiro (Osaka City Univ.). Osaka City Med. J., 8: 121-9(1962).

A chronological study was made of the turnover rate of Ca^{45} in the blood and the distribution of it in organs and tissues in young adult C strain rats (176 ± 4 days after birth) and old aged C strain rats (768 ± 34 days after birth) after the intravenous administration of $Ca^{45}Cl_2$. The smooth diminution curves of Ca^{45} for both groups were similar to their exponential curves. The old aged group showed a marked decrease in the first turnover rate over the young adult group. No significant difference in the second turnover rate was observed between the two groups. The kidneys, stomach, intestines, spleen, and heart revealed a considerably rapid transfer of Ca^{45} in the blood for old aged group, while the lungs, liver, muscles and bones revealed it for young adult group. The old aged group generally showed a slower transfer of Ca^{45} in the blood into organs and tissues especially into bones than the young adult group. (P.C.H.)

34 A SPECIFIC TYPE OF SKIN ALLERGY FROM BERYLLIUM BRONZE. M. Hula, F. Huzl, L. Lukesova, and J. Sykoral (Dermatology Clinic, Plzen, Czech.). Pracovni Lekar., 13: 497-9(Dec. 1, 1961). (In Czech.)

A description is given of the development of beryllosis in a lab assistant working with beryllium bronze. The condition was manifested as an allergic skin arteriolitis, associated with the formation of ulcers and severe decline in general condition. From an analysis of the worker's duties it appeared that the causative agent was beryllium oxide, which after repeated injuries caused by beryllium bronze fragments, penetrated the skin. Beryllium was estimated by spectrographic methods in tissues and excreta material. Therapeutic procedures are described. The skin manifestations responded best to the local administration of ethylenediaminetetraacetate (EDTA) ointment containing ascorbic acid and the parenteral administration of EDTA. However, no improvement in general condition resulted from these treatments. (BBB)

35 EXPERIMENTAL STUDIES ON THE METABOLISM AND THE DOSE CALCULATION IN ANIMALS WITH RADIOACTIVE LUTECIUM (Lu-177). Kyozo Kawasaki (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, 31-51(1961). (In Japanese)

Dose distribution of $Lu^{177}Cl_3$ was determined in rats and mice after subcutaneous, intraperitoneal, and intravenous injection. The best distribution was obtained after intravenous administration. The highest concentration was found in the spleen, with decreasing amounts in the liver, adrenal glands, ovary, bone, kidney, thymus, and thigh muscle. Internal radiation dose was calculated by integration of γ and β dose measurements. (C.H.)

36 STUDY ON METABOLISM WITH RADIOACTIVE PHOSPHORUS ^{32}P. CHAPTER II. ^{32}P METABOLISM IN NORMAL AND CASTRATED RATS UNDER INFLUENCE OF SEXUAL HORMONES. Mitumasa Saeki (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, Spec. Vol., 13: 22-30 (1960)). (In Japanese)

37 STUDY ON METABOLISM WITH RADIOACTIVE PHOSPHORUS ^{32}P. CHAPTER III. ^{32}P METABOLISM OF FETUS AND PLACENTA. Mitumasa Saeki (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 1053-9(1960)). (In Japanese)

38 STUDY ON METABOLISM WITH RADIOACTIVE PHOSPHORUS ^{32}P. CHAPTER IV. SUMMARY AND CONCLUSION. Mitumasa Saeki (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 1061-2(1960)). (In Japanese)

39 HOW TO REDUCE THE RADIOPHOSPHOR^{32} INCORPORATION IN THE CARCINOMA CELLS BY ADMINISTRATION OF NON-TOXIC DOSES OF CYTOSTATIC SUBSTANCES. I. Krepsz, A. Pupp, and F. Gyergyay (Univ. Tirgu-Mures, Rumania). Radiobiol. Radiotherap., 4: 479-82(1963). (In German)

Experiments on animals revealed that nontoxic doses of the cytostatics examined (Sarcolysin, Dimitan, Novoembichin, Trimitan, Bayer E-39, Mitomen, TEM, Degranol), as well as whole-body irradiations with 300 r, reduce the incorporation of P^{32} in the Ehrlich ascites carcinoma and the number of cells/mm^3 to varying values. The incorporation of P^{32} took place in the cells. The reduction of the activity of the carcinoma cells could not be brought into relation to the number of dead cells. The results of these experiments seem to indicate that the small doses of the examined cytostatics attack at different phases of the cellular metabolism. (auth)

40 TOLERANCE OF IRRADIATED FATS. Konrad Lang (Johannes Gutenberg Universität, Mainz). Z. Ernaehrungswiss., 2: 141-6(May 1962). (In German)

As is known, irradiation of polyene acids causes them to undergo similar changes as occur in auto-oxidation, and auto-oxidized fat can become toxic under certain conditions. Thus experiments were devised to study the effects of feeding fats irradiated by a substantially higher dose than is necessary for the sterilization or pasteurization of foodstuffs; to determine the radiation dose causing symptoms from irradiated fat; and the mechanism of the toxic effect. Sprague-Dawley rats were given soya oil, irradiated with 1-Mev electrons at 0, 2.5, 10, 50, and 100 Mrep doses. The fat made up 20% of the diet, which was supplemented with vitamins. With the 100-Mrep dose, after four weeks a depression in wt gain was observed which was connected with

a significant loss in the nutritional efficiency of protein. After 3-month feeding, lethal toxicity was noted and after 6 months 18% of the animals died. Only 88% of the 100-Mrep irradiated oil was absorbed. At the 50-Mrep dose a significant disturbance in the liver function and decrease of plasma proteins were observed. From the 24th week on there was an increasing wt loss and mortality rate; after 32 weeks, 12 male rats out of 40 had died. Animals fed on 10-Mrep irradiated oil also showed a high mortality after 40 weeks. Other symptoms observed were: histologically detectable hypofunction of the thyroid gland, decreased body temperature, decreased oxygen consumption, and bradycardia. Other experiments with 100-Mrep irradiated fish oil showed similar results in 10 weeks. The cause of death could not be determined. Notable was the increased wt of liver, deposits of brown pigment in liver and spleen, which upon treatment with NaOH reacted for iron. Water consumption of rats did not change. Also noted was a marked hypoproteinemia accompanied by a characteristic change of the electrophoretic patterns of serum proteins; γ-globulins increased to 25.9%, as compared with 17.2% in the control group. (BBB)

41 MEDICAL ASPECTS OF BERYLLIUM TOXICITY. Gino Zanolli. p.31-9 of "Nuclear Safety. Vol. 5, No. 1."

The medical aspects of beryllium toxicity and work in the prevention and treatment of beryllium disease are reviewed. Differences between the acute and chronic beryllium disease are discussed. The status of the patch test for beryllium disease, toxicity of different beryllium compounds, incidence and prevalence, and medical control are also discussed. The most typical, serious, acute toxic effects involve the lungs and result in a chemical pneumonia; there is a definite dose-effect relation, and recovery is the rule. The chronic disease significantly affects the lungs but is a slowly progressive disease for which a dose-effect relation is not known. It is frequently separated by a period of years from the time of exposure, is prolonged in duration with little evidence for cure, and is commonly progressive in severity despite cessation of exposure. (M.C.G.)

Radiation Effects

42 (AED-C-02-03) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. STRAHLENEINWIRKUNG AUF LEBENSMITTEL. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Radiation Effects on Food. Bibliography Compilation). Hanna Lueck (Germany. Forschungsanstalt fur Lebensmittelchemie, Munich). Sept. 15, 1962. 354p.

Approximately 1300 references on radiation effects on food are presented. These references are arranged in the following groups: reports, conferences, journal articles, books, dissertations, and patents. Indexes are included for report numbers, patent numbers, corporate authors, personal authors, and subjects. The time period of 1959 and 1960 is covered. (M.C.G.)

43 (CONF-250-3) RBE OF 440-Mev PROTON RADIATION COMPARED TO 125 kvp X-RAYS FOR $LD_{50(30)}$ OF MICE. F. J. Bradley, Joseph A. Watson, Donald P. Doolittle, Allen Brodsky (Pittsburgh. Univ. Graduate School of Public Health), and R. B. Sutton (Carnegie Inst. of Tech., Pittsburgh). [1963]. Contracts AT(30-1)-913; AT(30-1)-1825. 7p.

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Canada, Aug. 1963.

The relative biological effects of 440-Mev protons were compared with the effects of 125-kvp x rays using the $LD_{50(30)}$ of mice as the biological test system. Results are included for mice exposed to 730-Mev protons at a dose rate ranging from 500 to 1000 rad/min and 200-kvp x rays at 30 rad/min, and for mice exposed to 440-Mev protons at a dose rate of 80 rad/min and 250-kvp x rays at 43 rad/min. The values for relative biological effectiveness were calculated as 0.7 ± 0.2; 0.8 ± 0.1; and 0.7 ± 0.3, respectively. (C.H.)

44 (NYO-10703) EFFECTS OF SINGLE AND FRACTIONATED IRRADIATION ON THE EMBRYONIC DEVELOPMENT OF HAMSTERS. Elmer B. Harvey and M. C. Chang (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). [1963]. Contract AT(30-1)-1943. 23p.

Hamsters pregnant with 6.5- or 7.5-day embryos were exposed to single and fractionated doses of γ radiation ranging from 25 to 200 r. The threshold for mortality of 6.5-day embryos was about 75 r and of 7.5-day embryos was about 100 r. The percentage of abnormal fetuses increased from 5 to 100% following irradiation of either 6.5- or 7.5-day embryos with either single or fractionated doses over the range of 50 to 200 r. The development of pathological manifestation in relation to dose is discussed. (C.H.)

45 (TID-19545) EFFECTS OF H^3 THYMIDINE AS A DNA LABEL IN THE RAT LIVER. Progress Report, November 1, 1962–September 1, 1963. Joseph Post (New York Univ., New York and Goldwater Memorial Hospital, New York). Sept. 20, 1963. Contract AT(30-1)-2778. 6p.

It was found that the initial diploid population in liver cells of the male rat at birth change to a predominantly tetraploid population at 8 weeks of age and by 2 yr of age the octaploid group represents 15 to 20% of the cells. Results are reported from radioautographic studies of the effects of tritium-labeled thymidine used as a tracer in studies of desoxyribonucleic acid synthesis on ploidy classes in rat liver cells. Data are included on the effects of dosage level on the replication cycle of liver cells and from studies of the effects of age, injury, and tumor induction on cell replication patterns. (C.H.)

46 (TID-19578) THE NATURE OF CHEMICAL BONDING IN THE CHROMOSOME. Final Report. Norman S. Cohn (Ohio Univ., Athens). [1963]. Contract AT(11-1)-826. 7p.

Results are reported from a cytological analysis of chromosome aberrations in root tip cells of Vicia faba, Allium cepa, and Pisum sativum induced by x radiation or chemical radiomimetic substances. Emphasis was placed on the chemical nature of induced broken ends of chromosomes. (C.H.)

47 (TID-19617) EFFECTS OF X-IRRADIATION ON THE NERVOUS SYSTEM. Final Summary Report, June 1, 1958 to September 1, 1963. James R. Lott (North Texas State Univ., Denton). Aug. 28, 1963. Contract AT(40-1)-2419. 6p.

Data are summarized from studies of the effects of x irradiation on the nervous system. Studies of isolated rat tail nerve fibers showed that x radiation causes an increase in the amplitude of the action potentials. The dose rate appeared to be important in this response. X radiation altered the permeability of nerve membranes as reflected by changes in the rate of Na^{22} efflux from previously loaded nerve fibers. It is postulated that one may account for the enhancement period observed in the elec-

trical activity on the basis of increased, external cation concentration and the initial effect of x irradiation may be at the membrane level in response to physical changes in the membrane whereas the later, decremental phase may be due to biochemical damage that appears to be more irreversible. Possible effects of external and internal substances surrounding the membranes on changes in ionic balance induced by radiation are discussed. Results are included from studies in rats of the effects of irradiation of the central nervous system on response to selected drugs, with emphasis on tranquilizers. Implications of the findings in the response to drugs of patients undergoing daily radiation therapy are discussed. Studies on the role of certain brain centers in the radiation syndrome as reflected by changes in the output of various stress hormones by the adrenal cortex led to the hypothesis that sensitive receptor systems other than the retina alert animals and make them aware of minute amounts of ionizing radiation. The data indicate that these systems are distributed in the head and abdomen. (C.H.)

48 (USNRDL-TR-670) AROUSAL REACTIONS WITH A BRIEF PARTIAL- AND WHOLE-BODY X-RAY EXPOSURE. E. L. Hunt and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Sept. 23, 1963. 18p. (AD-421070)

A study was made to determine the sensitivity of the mammalian nervous system to nonvisual stimulation with ionizing radiation. Blinded rats were exposed, while asleep, to a 1-sec burst of x rays and measurements of behavioral arousal and heart rate were made to indicate activation of the central nervous system. The stimulus was immediately effective since reaction latencies of 1 sec or less were frequently recorded. The relative incidence of arousal and of a heart rate reaction, was found to be related to the radiation dose rate over the range of from 0.05 to 3.2 r/sec. The threshold dose rate was less than 0.05 r/sec. To test for regional distribution of sensitivity, additional blinded animals were exposed to a burst of x rays at the dose rate of 1.0 r/sec with exposure limited to the head region or to the rest of the body. In that arousal was elicited with exposure of either region it is evident that sensitivity to x-ray stimulation is widely distributed. Since exposure of the head produced a greater incidence and duration of disturbance, differential sensitivity between regions corresponds more closely to the density of ganglionic tissue than to the total tissue volume exposed. The results of the study are consistent with the postulation that ganglionic tissue is directly sensitive to ionizing radiation. (auth)

49 (JPRS-21472(Del.)) NUCLEIC ACID CONTENT IN THE TISSUES OF ANIMALS IRRADIATED AND TREATED WITH AN ANTI-RADIATION COMPLEX. M. F. Lipkan and M. T. Pindich. Translated from Ukr. Biokhim. Zh., 35: 514-18(1963). 8p.

Under the influence of nucleic metabolism activators after a lengthy period following irradiation (30 days), the restoration of the nucleic acid content in rats proceeds at a slower rate than in guinea pigs. Nucleic acid content in the small intestine wall is restored earlier than in other organs. This is more pronounced in guinea pigs. The nucleic acid content in the spleen is restored more slowly than in other organs; the liver occupies an intermediate position. (auth)

50 (JPRS-21628) THE PERMEABILITY OF THE HEMATOENCEPHALIC BARRIER TO INORGANIC PHOSPHATE IN ACUTE RADIATION SICKNESS. D. A. Chetverikov and S. V. Gasteva. Translated from Dokl. Akad. Nauk SSSR, 151: 718-21(1963). 6p. (OTS-63-41023)

The permeability of the hematoencephalic barrier (HEB) to inorganic phosphate was studied in rats during the acute phase of radiation sickness. Radioactive phosphate in the form of $Na_2HP^{32}O_4$ was injected subcutaneously, using a dose of 0.5 μC/g of body weight. The permeability of the HEB to inorganic phosphate was measured by the rate of passage of P^{32} from the plasma into the cerebral and spinal cord tissues. Data are presented on changes in specific radioactivity of the plasma, cerebral tissue, and spinal cord at various times after the injection of the phosphate and at various stages in the course of acute radiation sickness. It was concluded that a close connection exists between the rate of metabolic processes in the brain and the permeability of the HEB to the substances that participate in these processes. (C.H.)

51 THE GENE AND RADIATION MUTATION. H. Fritz-Niggli. Acta Iberica Radiol.-Cancerol., 17: 231-43(July-Sept. 1962). (In Spanish)

52 GROWTH INHIBITION AND MORPHOLOGIC CHANGES OF HeLa CELLS EXPOSED TO UNSATURATED FATTY ACID FRACTION FROM THE LIVER OF X-RAY IRRADIATED RABBITS (OX). Michio Yamamoto, Kozo Utsumi, and Satimaru Seno (Okayama Univ., Japan). Acta Med. Okayama, 16: 265-74(Oct. 1962).

The biological effect of the unsaturated fatty acid fraction from x-irradiated rabbit liver (OX) on HeLa cells was observed in vitro and compared with the effect on the same strain cells by the unsaturated fatty acid fraction from nonirradiated rabbits. The observations have proved that OX is a powerful cytotoxin in a concentration of 0.05 to 0.025% and induces a severe cell degeneration and cell death, resulting in a marked arrest in the growth of the cells. A similar effect has been observed by unsaturated fatty acid fraction from the nonirradiated rabbits, but the effect was much less compared to that of OX. Possible mechanisms of the cell damage by OX are discussed. (auth)

53 STUDIES ON THE COMPOUND LIPIDS FROM X-RAY IRRADIATED ANIMAL. I. CHARACTERISTICS OF COMPOUND LIPIDS FROM THE ORGANS OF X-RAY IRRADIATED RABBITS. Sachiko Ohara (Okayama Univ., Japan). Acta Med. Okayama, 16: 333-46(Dec. 1962).

An analysis was made of the compound lipids of the organs of rabbits irradiated with x rays. Silicic acid column chromatography was applied for the fractionation of the compound lipids. Each fraction was analyzed by silicic acid-impregnated paper chromatography and infrared spectrophotometry. The result proved that the compound lipids showed some qualitative and quantitative changes. The changes occurred mainly in glycerophosphatides showing the formation of high level lyso-phosphatidylcholine and lysophosphatidylethanolamine. The fatty acid compositions of the compound lipids were determined by means of gas-liquid chromatography. Further, polyunsaturated fatty acids were analyzed as fatty acid bromide. Major differences found in fatty acid patterns included: in the irradiated group the amounts of C_{18}-monoenoic, C_{18}-dienoic, C_{18}-trienoic, C_{20}-tetraenoic, and C_{22}-acids were decreased and of C_{16}- and C_{16}-monoenoic acids were increased. It has been elucidated that lysophosphatides not only possess a strong hemolytic power but also induce swelling of the rat liver mitochondria. It is suggested that the lysophosphatides and ethanolamine are responsible, at least partially, for the cell damage induced by x rays. (auth)

54 ACONITE-INDUCED VENTRICULAR TACHYCARDIA DURING RADIATION SICKNESS. V. Jurkovic, L. Vokrouhlicky, and Z. Belobradek (Second Medical

Clinic, Hradek Kralove, Czech.). Actualites Cardiol. Angeiol. Intern., 11: 291-6(Oct.-Dec. 1962). (In French)

In order to study cardiac excitability and the effects of procaine, ventricular tachycardia was induced by intramyocardial injection of 0.05 ml 50% aconite solution in irradiated and nonirradiated rabbits of both sexes. Tracheotomy and thoracotomy were performed to facilitate access to the heart and to establish artificial respiration through a tracheal tube. Narcosis was induced by urethane. Electrocardiograms were made at various stages in both control and irradiated animals; the former showed no change in preliminary phases of the experiment. Procaine was administered by subcutaneous injection, bilateral vagosympathetic infiltration, or slow intravenous infusion. Its therapeutic effect was determined by giving it 5 min after trachycardia occurred, and its preventive action by giving it 5 min before. The x irradiation rate was 16.6 r/min, to a total dose of 1000 r. On the 3rd day after irradiation, the therapeutic effect of procaine after intramuscular injection was seen as a 50% normalization of heart action, with less by other routes of administration; its preventive effect was seen as a 58% normalization following slow intravenous infusion but was insignificant by other routes. Six days after irradiation, at the peak of radiation sickness, procaine's therapeutic and preventive actions had almost disappeared; its intravenous therapeutic application gave 25% normalization and its intramuscular preventive action provided 20% normalization of heart rate. However, on the 6th day, a profibrillatory effect was observed, especially in the therapeutic vagosympathetic infiltration technique and the preventive use by slow intravenous infusion. Suggested explanations of the reversal are: change in excitability of myocardium when it is irradiated, or change in effect of procaine when the whole organism is irradiated. Results favor the first explanation. (BBB)

55 THE MOUSE KIDNEY AFTER X-IRRADIATION IN EARLY POSTNATAL LIFE. A STUDY OF IMMEDIATE AND DELAYED EFFECTS AND THEIR DEPENDENCE ON CELLULAR DIFFERENTIATION AND ORGAN STRUCTURE AT THE TIME OF EXPOSURE. Paul H. Guttman and Henry I. Kohn (Univ. of California, San Francisco). Am. J. Pathol., 43: 809-24(Nov. 1963).

The mouse kidney was examined for early and delayed changes after a single dose of 250 Kvcp x rays (whole-body exposure, 375 or 475 rads), on the day of birth (2 to 20 hr of age) or later, on day 12 or day 24. Early effects were those observed within 14 days and were found only in mice irradiated on the day of birth; they were restricted to the residual metanephrogenic subcapsular tissue and consisted of degenerative changes in primary cells, reduction in the amount of neogenic tissue, maturation arrest, and compensatory hypertropy of the tubules. Two types of delayed changes were observed in the mice irradiated on the first day of life: a rapidly developing lesion first noted 24 days after exposure, which involved the mesangium of incompletely differentiated glomeruli in the outer cortex; and a slowly progressive intercapillary glomerulosclerosis, first detected 35 to 47 days after exposure, which appeared in fully developed glomeruli situated in the inner cortex. Transition forms between the two were observed. Animals irradiated at either 12 or 24 days of age developed changes of the latter type after a latent period of 65 days or more; no immediate effects were observed. (auth)

56 PRIMARY PROCESSES OF DEPOSITION OF RADIANT ENERGY AND INITIAL RADIOCHEMICAL EVENTS. John W. Boag (Mount Vernon Hospital, Northwood, Middx, Eng.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 896-906(Nov. 1963).

Recent information on the nature and behavior of the primary species formed by ionizing radiation in biological systems is reviewed. It is pointed out that the biological effects of ionizing radiation are the end result of a complex chain of processes that begins with the initial transfer of energy from the primary radiation to the molecules of the irradiated material. Pathways by which this energy may pass through the form of molecular ionization or excitation, dissociation, and radical formation, before it is finally degraded to heat or to permanent chemical change are discussed. (C.H.)

57 BIOCHEMICAL BASIS OF REPRODUCTIVE DEATH IN IRRADIATED CELLS. Henry S. Kaplan (Stanford Univ., Palo Alto, Calif.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 907-16(Nov. 1963).

The roles of desoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in reproductive death in irradiated cells are discussed. Data are reviewed from biochemical analysis, from studies utilizing the molecular biological approach to observe the incorporation of a series of analogs of natural purine and pyrimidine bases in nucleic acid, from studies on radioinduced changes in oxidative phosphorylation, from studies of radiation effects on enzyme activity, and from studies of radiation effects on DNA synthesis. It is concluded that the primary radiobiochemical lesion leading to uv-induced cell death of bacteria and bacteriophages occurs in DNA. It is pointed out that as biologic complexity increases there is a marked decrease in relative radiosensitivity and mammalian cells are much more resistant than would be predicted by extrapolation from microorganism data. It is suggested that repair mechanisms, presumably enzymatic in nature, may induce repair of radiation injuries and that only a small fraction of the lesions induced in DNA by radiation persist long enough to be expressed biologically. Such repair mechanisms may be more highly developed in the more complex cells of higher organisms and result in a decreased radiosensitivity. (65 references) (C.H.)

58 QUANTITATIVE ASPECTS OF RADIATION LETHALITY AT THE CELLULAR LEVEL. J. E. Till (Ontario Cancer Inst., Toronto). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 917-27(Nov. 1963).

Radiobiologic studies on normal and tumor cells of the mouse in vivo and extensive similar studies on normal and malignant cells proliferating in tissue culture, including human cells and cells derived from other mammals, indicate that all proliferating mammalian cells have approximately the same intrinsic radiosensitivity as far as the effect of radiation on the proliferative capacity of the cells is concerned. In particular, tumor cells and proliferating normal cells do not differ greatly in sensitivity, with the tumor cells showing, if anything, the lesser radiosensitivity. Factors which modify the radiosensitivity of cells do not appear to act selectively on either tumor or normal cells. Of critical importance in assessing the action of radiation on a tumor cell population is a knowledge of how many cells in the irradiated tumor possess the capacity for unlimited proliferation and the kinetics of multiplication of these cells after irradiation. The greatest block to progress in the understanding of the differences in radiocurability between different human tumors is the lack of a direct method for determining the proliferative capacity of cells in human tumors. If such a method could be developed, a more rational approach to diagnosis and treatment would be possible. (auth)

59 QUANTITATIVE ASPECTS OF RADIATION EFFECTS AT THE TISSUE AND TUMOR LEVEL. Harvey M. Patt (Argonne National Lab., Ill.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 928-37(Nov. 1963).

The radiation response of a cell renewal system is more than a function of the intrinsic sensitivity of its components. The sequence of depopulation and repopulation depends upon the dynamic organization of the system. Although it is possible to relate the chronology of effects to normal kinetics, minor deviations of flow patterns and turnover constants can have profound significance for the fate of the system. As a rule, lesions develop faster and are repaired sooner in more rapidly renewing tissues. The rate of expansion of tumors may be much slower than the rate of renewal of many normal tissues. This probably accounts for at least some of the selective advantage of dose fractionation. The various cell transitions and fluxes during tumor growth are not well understood, and further information about the kinetic patterns is germane to rationalization of therapeutic procedures. (auth)

60 AN UNUSUAL CASE OF RADIUM TOXICITY. H. F. Lucas, Jr., R. E. Rowland, C. E. Miller, R. B. Holtzman, R. J. Hasterlik, and A. J. Finkel (Argonne National Lab., Ill.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 1042-51(Nov. 1963).

The case history for an unusual case of radium toxicity is reviewed. Whole-body gamma radiation counts, radon breath measurements, and fecal analyses were made over a period of 5 months before death at age 54, and roentgenograms made before and after amputation of a leg with osteoblastic osteogenic sarcoma were studied. Radioautographic and microradiographic studies were done on bone samples obtained at autopsy. The patient had no history of radium exposure. A series of injections for treatment of a skin condition at age 15 or 16 was considered a possible source of Ra exposure, but no direct evidence was available. On the basis of whole-body measurements, it was estimated that the patient contained 0.49 μC of Ra^{226} at the time of death. The technique used to establish the date, route, and amount of radium exposure is described in detail. The importance of the initial amount of radium in the body on the carcinogenic process is discussed. (C.H.)

61 EFFECTS OF RADIOCOBALT IRRADIATION OF PREGNANT RABBITS ON THE DEVELOPMENT OF FETUSES. M. C. Chang, Dorothy M. Hunt, and Elmer B. Harvey (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Anat. Rec., 145: 455-65(Mar. 1963).

Female rabbits were irradiated from a radiocobalt source on various days of pregnancy and examined three to five days before delivery. Following irradiation at 400 r, on days two, four, or six before implantation, 24% of the embryos implanted and 19.9% developed into apparently normal fetuses; on day seven or eight at the time of implantation or soon after, all embryos died although 61% implanted; on days 9, 10, or 11, 16.5% of the embryos developed into living fetuses with high incidences of short tail and cleft palate and with low incidences of abnormal forelimbs, fused digits of forelimbs and exencephalia; on days 12, 13, or 14, 35% of the embryos developed into fetuses with a high incidence of fused digits in the fore- or hind-limbs; on days 15 to 22, 30% of the embryos developed into living fetuses without gross abnormalities. Irradiation at 250 r on day eight did not cause death of all embryos as it did at 400 r. With irradiation at 250 r on days 8 to 14, 51 to 60% of the embryos developed into living fetuses with low incidences of abnormalities. The size of fetuses was reduced very little following irradiation on days two to six or on days 18 to 22. But the size is distinctly reduced following the irradiation on days 11 to 16. Necrosis of tissue, pycnosis of nuclei, and vacuolation of cells in the embryos were observed six hours after the irradiation of mothers at 400 r on days seven and eight. (auth)

62 RADIOSENSITIVITY TO P^{32} OF BACTERIA CULTIVATED IN A P^{31}-FREE MEDIUM. Antonina Guelin and Pierre Lepine (Institut Pasteur, Paris). Ann. Inst. Pasteur, 104: 450-9(Apr. 1963). (In French)

Observations were made of the behavior of Shigella paradysenteriae Y6R in nutrient solutions in which radiophosphorous (P^{32}) was substituted entirely or partially for P^{31}. Approximately 5 μg/ml of P^{31} was present in the medium; the specific activity of the $H_3P^{32}O_4$ used was 5 mC/μg, and specific activity of culture medium varied from 5 to 80 μC/ml. Bacterial growth in the presence of P^{32} was slow at first, but was inhibited only in media totally deprived of P^{31}. Partial replacement of P in the medium by P^{32} did not re-establish normal growth. Bacterial survival time in presence of P^{32} was shorter in media lacking P^{31}. Radiosensitivity of bacteria to P^{32} was higher in a medium deprived of P^{31}; P^{31} exerted a protective effect against P^{32}. Radiosensitivity to P^{32} in P^{31}-deficient medium was a function of the size of the original bacterial inoculum. Bacterial growth persisted in media containing relatively high radioactivity (80 μC/ml). Radioresistance of bacteria to P^{32} in a medium deprived of P^{31} was higher with a larger number of bacteria/ml. The incorporation of P^{32} by bacteria was greater in media lacking P^{31}, also in the presence of few bacteria, or with a higher level of radioactivity in the medium. Under the experimental conditions used it was not possible to replace the incorporated P^{31} by P^{32} in a medium rich in P^{32}. The decrease of bacterial resistance to P^{32} seems partially due to a more intensive fixation of P^{32} than P^{31}. Acid-soluble and non-acid-soluble (lipid, nucleic acid, protein) fractions were prepared and analyzed for P^{31} and P^{32} in media containing various P^{32}/P^{31} ratios. Prior exposure of bacteria to P^{31} did not affect P^{32}-incorporation in the acid-soluble fraction, but slightly increased P^{32} uptake by nucleic acid and slightly decreased it in lipid and protein fractions. (BBB)

63 EFFECTS OF X-IRRADIATION ON SEEDS OF "ARABIDOPSIS THALIANA." Marcello Buiatti and Carlo Lorenzoni (Università, Pavia, Italy). Caryologia, 16: 101-10(Jan.-Apr. 1963). (In Italian)

The first generation effects of three doses of x rays (20, 40, and 80 kr) on dry seeds of Arabidopsis thaliana (L.) Heinh. were studied. The following parameters were analyzed: germination percentage, survival at flowering, length of primary root at the 7th day from germination, date of appearance of the influorescence, flowering date, percentage of plants in bloom at the 19th day from germination, plant height at harvest, number of primary branches at harvest, number of fertile pods and number of seeds per plant. A statistical analysis of means and variances showed a depressing action on means exerted by the highest dose; no action or, in one case, a stimulating effect by lower doses was noticed. Variances in treated materials were lower than in controls for the characters analyzed in the first stages of development, higher for the others. As a tentative explanation of this phenomenon there is suggested the existence of a dynamic ontogenetic equilibrium between the damage due to physiologic actions and chromosomal aberrations and induction of heterozygosity exerting a homeostatic effect. (auth)

64 HAPLOIDS. M. L. Magoon and K. R. Khanna (Indian Agricultural Research Inst., New Delhi, India). Caryologia, 16: 191-235(Jan.-Apr. 1963).

The value of haploids in plant breeding programs is discussed. The role of the haploid phase in the life cycle in the development of various plant species is reviewed. Results are reported from studies on the effects of x radiation and treatment with P^{32} on the frequency of haploids in Zea mays, wheat, and other plants. (C.H.)

65 NEW OBSERVATIONS ON LECANOID SPERMATOGENESIS IN THE MEALY BUG, PLANOCOCCUS CITRI. Walter A. Nelson-Rees (Max-Planck-Institut für Meeres-biologie, Tübingen, Ger.). Chromosoma, 14: 1-17(1963).

A reexamination of the second spermatogenic division of the mealy bug, Planococcus citri (Risso), a lecanoid coccid, has revealed hitherto unknown spindle activity of the euchromatic set of chromosomes during anaphase II. An initial large half spindle elaborated by the heterochromatic chromosomes in early metaphase, gives way to a less pronounced, but clearly visible bipolar spindle involving both sets of chromosomes at early anaphase. There is no lengthening of the spindle or cell, but the separation of the chromosomes occurs around the periphery of the cell with the aid of interzonal activity. The active participation of the euchromatic chromosome during the separation is furthermore inferred by the formation of bridges resulting from euchromatic-hetero-chromatic translocations. (auth)

66 OBSERVATIONS ON DICENTRICS IN LIVING CELLS. A. Bajer (Univ. of Lund, Sweden). Chromosoma, 14: 18-30(1963).

In previously irradiated endosperm cells of Haemanthus katherinae (Bloody Lily) studied in vitro by means of microcinematography, two-kinetochore chromatids and dicentric chromosomes were observed. Breaking of such dicentric chromatids and chromosomes was analyzed. Behavior of some of the dicentric chromosomes during anaphase deserves special attention: interlocking dicentrics cut one through another and rejoin in a few minutes. In this way from a metaphase interlocking dicentric, two sister anaphase dicentrics are formed. Interlocked dicentrics can also uncoil and not break at all. In this case no activity was observed in one kinetochore of one dicentric in later stages of anaphase (two kinetochores were active in one dicentric and only one in its sister). Analysis of chromosome movements in two-kinetochore chromatids and dicentrics is also presented. (auth)

67 CYTOGENETIC STUDIES FOLLOWING HIGH DOSAGE PATERNAL IRRADIATION IN THE MEALY BUG, PLANOCOCCUS CITRI. I. CYTOLOGY OF X_1 EMBRYOS. H. Sharat Chandra (Univ. of California, Berkeley). Chromosoma, 14: 310-29(1963).

In the mealy bug, Planococcus citri, following high dosage paternal irradiation (60,000 to 120,000 rep), the survivors are mostly female (about 30 to 40% of the unirradiated control value) whereas very few males survive (about 5% of control value). After lower doses of paternal irradiation (P.I.), however, few or no females survive while the normal number of males (never less than the control value) survive. The females developing after high dosage P.I. are gynogenetic and are triploid or diploid or 3N/2N or 2N/N mosaics. The cytology of X_1 embryos following 90,000 rep is described in comparison with data from embryos following lower doses (8,000 r) of P.I. and unirradiated controls, to illustrate the chromosomal mechanisms leading to the production of gynogenetic females and the probable reasons for lethality of X_1 males after heavy P.I. It has been shown that triploid females stem from a fusion nucleus of the first and second polar bodies. This triploid polar nucleus, which normally participates in the formation of a polyploid sector in the young embryo, undertakes a successful embryogeny in many embryos when the zygote nucleus is unable to do so because of the heavily damaged paternal complement of chromosomes. Since the chromosomes are characterized by holokinetic activity, the irradiated paternal set manages to divide with the maternal complement but did not always segregate as successfully. Restitution divisions of the zygotic nuclei result in haploid, hyperhaploid, diploid and polyploid nuclei. Most of the diploid gynogenetic females probably originate from diploid nuclei of zygotic origin although it is possible that a few diploid females and the 2N/N mosaic females develop from polar bodies. (auth)

68 CYTOGENETIC STUDIES FOLLOWING HIGH DOSAGE PATERNAL IRRADIATION IN THE MEALY BUG, PLANOCOCCUS CITRI. II. CYTOLOGY OF X_1 FEMALES AND THE PROBLEM OF LECANOID SEX DETERMINATION. H. Sharat Chandra (Univ. of California, Berkeley). Chromosoma, 14: 330-46(1963).

When females of the mealy bug, Planococcus citri, are mated to males previously irradiated with heavy doses of γ rays (30,000 to 120,000 rep), the progeny is mostly female. These X_1 females are gynogenetic, with unbroken chromosomes. Detailed cytology of 17 such gynogenetic females showed triploids, diploids, and 3N/2N and 2N/N mosaics. Most of the embryos produced by triploid mothers were aneuploid and these degenerated before gastrulation. Regardless of aneuploidy, male embryos showed the typical lecanoid heterochromatization of the paternal set of chromosomes. Just prior to degeneration, the euchromatic chromosomes in the aneuploid male embryos showed endomitotic splitting while the heterochromatic did not. Among the progeny of 3N ♀ × 2N ♂ matings, only males with 5 euchromatic + 5 heterochromatic chromosomes and females with 10 or 15 euchromatic chromosomes were found. A search for adults with 5 heterochromatic + 10 euchromatic chromosomes among the progeny of triploid mothers was unsuccessful. Chromosomal variables such as aneuploidy of the euchromatic set, haploidy and fragmentation are discussed in relation to the problems of heterochromatization of the paternal set and sex determination in this species. (auth)

69 SOUND-INDUCED SEIZURES IN LONG-SURVIVING PRENATALLY X-IRRADIATED RATS. Lester M. Geller and David Cowen (Columbia Univ., New York). Exptl. Neurol., 7: 366-74(May 1963).

Rats exposed to 250-r x radiation in utero, on either the 18th or 19th day of pregnancy, were tested for their susceptibility to sound-induced seizures at a median age of $21\frac{1}{2}$ months. No significant association between incidence of seizures and prenatal x irradiation was found. Some indication that x irradiation in utero enhanced the reactivity of seizure-susceptible animals was noted. It was concluded that audiogenic seizure susceptibility cannot be considered either a long-term or a sensitive indicator of the effect of x irradiation upon the central nervous system. The results are in conflict with those of Werboff, who reported an increase in seizure responses in the offspring of animals exposed to x radiation in the third trimester (day 15 and 20) of pregnancy, and tested at four months of age. The increase was unrelated to dosage (100 r, 50 r, or 25 r) or to day of gestation when x irradiated. They suggested that susceptibility to audiogenic seizure is a sensitive and long-lasting indicator of the effects of x ir-

radiation upon the central nervous system. More generally, they concluded that their levels of x irradiation altered the threshold of susceptibility to sound-induced seizures when the animals were tested later in life. Since audiogenic seizure susceptibility appears to be, at least in part, an age-related phenomenon, repeated testing of prenatally x-irradiated rats might demonstrate, at specific periods of life, a significant relation between the early treatment and the incidence of later response to the sound. Such an effect also presumably would be related to the dose of x irradiation to which the animals were exposed in utero, and to the day of gestation when they were irradiated. (BBB)

70 VARIABLES IN X-RAY INACTIVATION OF NIPPOSTRONGYLUS BRASILIENSIS LARVAE. F. W. Jennings, W. Mulligan, and G. M. Urquhart (Veterinary School, Glasgow). Exptl. Parasitol., 13: 367-73(June 1963).

Variables other than the x-ray dose which might influence the inactivation process of the parasites were examined, including rate of delivery of the x-ray dose, larval concentration during irradiation, and fecal contamination of the larval suspension. Samples of N. brasiliensis larvae at a concentration of ~10,000 larvae per ml were treated with 140-kv x-ray doses of 40, 80, 120, and 180 kr at dose rates of 235, 495, and 735 r/min. At all dose rates, as the total x-ray dose increased, the number of worms found in the small intestine of rats inoculated with irradiated larvae decreased but more worms were recovered from the lungs. In all cases the proportion of the total worm burden found in the lungs ranged from less than 15% in the controls to 100% at 160 kr. There are thus two criteria which may be used to assess the degree of inactivation produced by x irradiation of N. brasiliensis larvae: the numbers of worms found in the gut and the distribution of worms between lungs and gut. As judged by both criteria, there was no significant difference between the results obtained at the three different dose rates. When suspensions of larvae containing 1500, 9000, and 50,000 per ml were treated with an x-ray dose of 80 kr, at a dose-rate of 735 r/min, there were no significant differences between the results obtained with larvae irradiated at concentrations of 50,000 or 9000 per ml. Larvae irradiated at 1500 per ml were markedly more inactivated than those treated with the same x-ray dose at the higher concentrations, both from the small numbers found in the gut and the high lung/gut ratio. Thus in relatively dilute larval suspensions (1500 per ml) an enhanced inactivation takes place. The presence of fecal contamination, even up to the extent of 10% dry matter in the solution, had no effect on the inactivation of N. brasiliensis larvae by x rays. (BBB)

71 TRANSLOCATIONS IN STOCK STRAINS OF ASPERGILLUS NIDULANS. Etta Kaefer (McGill Univ., Montreal). Genetica, 33: 59-68(1962).

Genetic methods for detection and analysis of translocations are described and illustrated with the case of a translocation involving linkage groups I and VII. Methods are outlined for ascertaining standard chromosome complements in stock strains of A. nidulans, which show high frequency of radioinduced translocations, and the general importance of chromosomal rearrangements in microorganisms is emphasized. (auth)

72 DEVELOPMENTAL HOMEOSTASIS IN X-RAYED POPULATIONS OF DROSOPHILA PSUEDOOBSCURA. A. O. Tantawy (Univ. of Alexandria, Egypt). Genetica, 33: 222-43(1963).

An experiment was designed to study the effects of various dosages of x irradiation on different gene arrangements (AR and CH) of the third chromosome of D. pseudoobscura, with respect to quantitative characters. Egg production showed an insignificant decline at 1500 r and an increasingly strong reduction by 3000 and 4500 r. Other characters studied (emergence, longevity, body size, and weight) generally showed the same trend. Irradiation of both gene arrangements usually gave more reduction in fitness characters than did irradiation of one gene arrangement alone. Irradiation caused an increase in phenotypic variability as expressed by coefficients of variation. Heterosis in F_1 was observed for most of the characters studied, and a breakdown of heterosis in F_2. Heterosis was enhanced by irradiation at higher dosages. Relative indices of general performance indicate that the adaptive values decreased with the increase in radiation dosages. In all cases the heterozygous genotypes are the fittest while the CH/CH homozygote was the least fit. (auth)

73 RADIATION-INDUCED DOMINANT LETHALITY IN HAPLOID AND DIPLOID SPERM OF THE WASP MORMONIELLA. R. K. Mortimer and R. C. von Borstel (Univ. of California, Berkeley; Università, Pavia, Italy; and Oak Ridge National Lab., Tenn.). Genetics, 48: 1545-9(Nov. 1963).

A doubling of the chromosome complement on Mormoniella sperm from haploid to diploid doubles the sensitivity to radiation when dominant lethality is the criterion. (auth)

74 THE INDUCTION OF MINUTE MUTATIONS IN DROSOPHILA WITH TRITIUM-LABELED THYMIDINE. Oeistein Stroemnaes and Ingerid Kvelland (Universitetet, Oslo). Genetics, 48: 1559-65(Nov. 1963).

Drosophila melanogaster adult males were injected with tritium-labeled or unlabeled thymidine when 1 to 24 hr old. One and a half days later they were mated to a series of females, to sample sperm delivered over successive three-day periods, furnishing six three-day broods. The injected males in the labeled series were less viable and fecund than those in the control series. The sixth brood in the labeled series had a significantly higher frequency of Minutes than any other brood in either series and had the lowest frequency of wild-type males. The frequency of mosaic females and of phenotypic hemithorax flies was significantly higher in the labeled series than in the control series. (auth)

75 STUDIES OF MEIOSIS IN LUZULA PURPUREA. Hedda Nordenskiold (Agricultural Coll., Uppsala). Hereditas, 48: 503-19(1962).

In Luzula purpurea, which has diffuse centromeres and only six chromosomes, a study was made of the separation of chromatids during the first meiotic division, the pairing of the free chromatids at interkinesis, and the chromosomes of first mitosis of the pollen tetrads. Two strains were used, the normal type of L. purpurea with 2n = 6, and certain plants selected among the x-irradiated survivors. The normal plants had six somatic chromosomes of equal size that could not be distinguished from each other. The x-irradiated plants originated from material treated with 2500 or 1000 r as seedlings. Mitotic chromosome patterns were examined in progenies of the treated plants. Several of the irradiated plants were found to have 2n = 7 with five normal-sized chromosomes and one chromosome fragmented into two pieces of about equal size. Pairing of chromosomes during meiosis in these irradiated plants was compared with that in the normal L. purpurea with 2n = 6, and the distribution of large and small chromosomes between the four cells of the pollen tetrads was

examined. Five of the original six chromosomes were unaffected by the x-ray treatment. A study of meiosis verified the postulated type of fragmentation of the 6th one. One heteromorphic association is formed in each cell of meiosis, originating from the pairing between the two fragments and their homologous unbroken partner. The association is open at metaphase and separates equationally during first anaphase. In the tetrad the two fragments regularly substitute the broken chromosome. The plants behave cytologically in the same way as the hybrids between diploid strains and naturally occurring endonuclear polyploids with half-sized chromosomes. In the next generation plants homozygote for the fragmented chromosome were found, showing a regular meiosis with two large and two small bivalents. The origin of the single fragmented chromosome in the irradiated material is difficult to explain; however, it was found earlier that chromosomes broken by x rays may persist as fragments in L. purpurea. It is noteworthy that the result of the fragmentation corresponds to the naturally occurring changes of chromosome pattern found in the genus Luzula. The pairing behavior of the chromosomes during meiosis in the heterozygote is the same as the one described for corresponding hybrids of L. campestris as well as the distribution of the large and the small chromosomes between the tetrad cells, where two half-sized chromosomes always substitute one large one. In such a case the progeny plants, homozygous for the fragmented chromosome, can give rise to a population which may be considered as an artificially produced endonuclear aneuploid strain, similar to the ones naturally found in the genus Luzula. (BBB)

76 A STUDY OF MEIOSIS IN THE PROGENY OF X-IRRADIATED LUZULA PURPUREA. Hedda Nordenskiold (Agricultural Coll., Uppsala). Hereditas, 49: 33-47 (1963).

In Luzula the chromosomes have diffuse or nonlocalized centromeres; thus, if the chromosomes are broken or rearranged by x-ray treatment, the changed chromosome patterns may survive through the mitotic cell divisions, on account of the centromeric action along the whole chromosomes. Hence, such plants with diffuse centromeres are able to survive and reach adult stages in spite of the fact that their chromosomes have been rearranged or broken by x-ray treatment of the seedlings. A study was made of plants selected from the progeny of material treated as seedlings with 1000 or 2500 r. Plants treated with stronger doses (5000 to 10000 r) were almost or completely sterile. The chromosome patterns of the root tips of X_2 plants were investigated in order to find plants with desirable chromosome patterns for the meiotic investigation. The x-irradiated plants themselves showed intricate metaphasic configurations during meiosis. The separation of the multi-associations at first anaphase is cytologically equational, and in most cases without bridges. Migration of chromatids during second anaphase is also regular without lagging chromosomes, but chromosome sets of 4 tetrad cells usually become unbalanced, causing reduced fertility. The mitotic chromosome patterns of X_2 plants showed three categories of patterns: 2n = 6; most of these plants have all chromosomes the same size, but some of them possess one long and one short chromosome indicating a reciprocal translocation between two chromosomes; 2n = 7, with one of the original chromosomes fragmented into two pieces; and 2n = 8, with two of the original chromosomes fragmented into two pieces each. A study was made of meiosis in X_2 plants with a cytologically observable rearrangement in the root tips, determined as a reciprocal translocation. They had reduced fertility, but seeds and progeny plants were obtained. Meiosis of X_2 plants heterozygous for one chromosome fragmented into two pieces, i.e., possessing 2n = 7 with five normal-sized and two small half-sized chromosomes, was also studied. The expected course of meiosis was realized, giving rise to four balanced chromosome sets of the tetrads, two of them containing three normal-sized chromosomes and the remaining two having two normal-sized and two half-sized ones. These studied plants were all fertile. Examination of somatic chromosome patterns of the progenies originating from the X_2 plants heterozygous for one fragmented chromosome revealed the three expected chromosome patterns, i.e., 2n = 6, 2n = 7, 2n = 8. X_2 plants with 2n = 8 were homozygous for the fragmented chromosome, and had a completely regular meiosis with two large and two small bivalents during first metaphase and a regular pairing and separation during the second division. Consequently they gave rise to a fertile strain with a constant chromosome pattern. The origin of the aneuploidy and endonuclear polyploidy of material with diffuse centromeres was discussed in relation to the survival of the fragmented chromosomes in L. purpurea. The survival of broken chromosomes through consecutive generations thus gives an explanation of the occurrence of aneuploid chromosome numbers in material with diffuse centromeres. However, no interpretation of the phenomenon causing the survival of the fragments was provided by this study, since sufficient knowledge about the nature of the diffuse or nonlocalized centromeres is unavailable. (BBB)

77 THE ABSCOPAL EFFECT OF X IRRADIATION ON BONE GROWTH IN RATS. Arthur M. Pappas and Jonathan Cohen (Children's Hospital Medical Center, Boston, Mass.). J. Bone Joint Surg., 45A: 765-72(June 1963).

The abscopal effect of irradiation (that which is evident at a distance from the irradiated volume but within the same organism) was investigated in rats. It was possible to demonstrate the effects on growth locally and abscopally when x-ray doses of 400 and 800 r were delivered to the lower extremity and when 800 r was delivered to the knee alone. A distinction between abscopal effects after local irradiation and systemic effects after whole-body irradiation is discussed. The weights of control and irradiated animals were similar for the first 21 days, during which period they did not exhibit any untoward effects of irradiation. However, after 21 days there was a decrease in weight gain, which persisted until the 72nd day. Group A (controls) was the heaviest group, with a mean weight of 412 g. Group B (800 r to the left hind extremity) had a mean weight of 378. Group C (400 r to the left hind extremity) and Group D (800 r to the left knee) exhibited mean weights of 391 and 394 g, respectively. Roentgenographic measurements revealed that all animals receiving irradiation had retardation in the growth of the irradiated tibiae, which were shorter than both the control and the contralateral (unirradiated) tibiae. Only the animals that had received 800 r to their left hind extremity showed significant differences in the lengths of their unirradiated bones compared with the bones of the control animals of Group A, that is, a significant abscopal growth retardation. Although the abscopal effect appeared to be associated with the volume of tissue irradiated, the way this effect is mediated is not known. The weight gains of the animals demonstrated a strong association between decrease in weight gain, the volume of tissue irradiated, and the dose administered. The impaired weight gain roughly paralleled the abscopal retardation of bone growth. The animals which received the highest dose of irradiation, 800 r, to the largest volume

of tissue, 10% of the body volume, revealed the greatest deviation from the control group. It is concluded that irradiation effects in animals are composites of the responses of the whole organism to the injury, of the responses of local tissues, and vessels at their level of tissue organization, and of the responses of individual cells. All of these responses may be interdependent. The evidence indicates that a systemic inhibition of all bone growth and weight gain occurs when a sufficient volume of tissue is irradiated at a sufficiently high dosage. (BBB)

78 EFFECTS OF GAMMA RADIATION ON THE FERTILITY AND LONGEVITY OF DROSOPHILA MELANOGASTER. T. J. Henneberry (Dept. of Agriculture, Beltsville, Md.). J. Econ. Entomol., 56: 279-81(June 1963).

Untreated female flies of Drosophila Meigen strain mated with males exposed to 4 kr of Co^{60} γ radiation in the larval, and 16 kr in the pupal or adult stage deposited the normal number of eggs, none of which hatched. Females irradiated in the pupal or adult stage with 8 or 16 kr and mated with untreated males produced few or no eggs. Females irradiated in the larval stage produced fewer eggs after exposure to high doses of radiation than untreated females but showed no reduction in the percentage of emerging adults. Untreated female flies mated with irradiated males (16 kr) produced sterile eggs, but when mated a second time with untreated males, produced viable eggs. Untreated female flies mated with normal males produced viable eggs, but when subsequently mated with irradiated males, they continued to produce viable eggs. Sterile males confined with normal males and females reduced the number of progeny, suggesting the possible use of irradiated males to control the population of the flies. That females mate only once is not required to control population size; the important factor is the introduction of dominant lethality in the population. Longevity of male or female flies irradiated in the pupal or adult stage was not affected by irradiation. Male and female flies exposed in the larval stage to 4 kr were shorter lived than flies from untreated larvae or larvae exposed to 1 kr. Females irradiated in the larval stage with 2.5 kr were shorter lived than females from untreated larvae or larvae exposed to 1 kr. (BBB)

79 THE RESPONSE OF BLOOD-FED AEDES AEGYPTI TO GAMMA RADIATION. Nathan Stahler and Levon A. Terzian (Naval Medical Research Inst., Bethesda, Md.). J. Econ. Entomol., 56: 416-17(June 1963).

A study was undertaken to learn if the survival of blood-fed female mosquitoes was significantly different from that of the non-blood-fed groups after whole-body γ irradiation. The mosquitoes were irradiated on the 4th postemergence day by a Co^{60} irradiator of 4 π geometry at 300-400 r/min in air, at a dose of 15000 r. Blood meals were offered on the 3rd, 10th, 17th, 24th, 31st, 38th, and 45th postemergence days. The maximum mortality was obtained in the group only irradiated, and the minimum mortality occurred in the one only blood-fed. The blood-fed, irradiated group and the one which had neither been blood-fed nor irradiated showed intermediate mortality rate. The number of days at which 50% mortality had occurred was compared. In order of lethality they were: irradiated and not blood-fed, 31; not irradiated and not blood-fed, 34; irradiated and blood-fed, 35; and not irradiated but blood-fed, 44. The same order applied to the point of 90% mortality was 45, 48, 49, and 67. The data clearly suggest an attenuation of radioinduced lethality in blood-fed A. aegypti, whether considering either the blood-fed or the non-blood-fed groups as the controls. Since the toxic mechanisms operating within irradiated mosquitoes are not known, there is no way of determining whether blood contributed towards a restorative process as a true radiotherapeutic agent or acted independently and masked these changes by increasing the metabolic rate or storage of nutrients. The latter has been previously suggested to account for the greater resistance of female insects to ionizing irradiation. (BBB)

80 ADJUSTMENT TO FOOD DEPRIVATION CYCLES AS A FUNCTION OF AGE AND PRENATAL X IRRADIATION. R. Stephen Tacker and Ernest Furchtgott (Univ. of Tennessee, Knoxville). J. Genet. Psychol., 102: 257-60(June 1963).

Rats exposed to 100- to 200-r doses of x rays in utero between days 14 and 18 of gestation were placed on a 22-hr food deprivation cycle. Their ages at the start of the experiment varied from 75 to 735 days. Speed of adjustment to the food deprivation, measured in terms of the number of days that body weight losses occurred, was inversely related to age, and at every age level the x-irradiated rats adjusted more slowly than the control animals. The initial greater weight and excess body fat of the older animals probably accounts for their slower adjustment to the deprivation schedule. Also, central nervous system (CNS) factors, which play an important role in feeding, are probably less efficient in older subjects. The greater loss in body weight and slower adjustment of the irradiated rats at every age level was surprising since in each group they weighed initially less than the controls, and thus presumably had a greater caloric need. Hence it would seem plausible to invoke CNS deficiency as a major factor retarding the animals adjustment to the feeding regimen. Previous studies have demonstrated learning deficits in prenatally irradiated rats. The hypothesis is presented that irradiated animals are slower in learning to eat a sufficient amount during the 2-hr feeding period, even though they weigh less than controls, and thus their caloric deficit is greater. It is also proposed that the irradiation effects mimic aging. The inverse relation between adjustment to food deprivation and age, and the slower adjustment of the irradiated subjects at every age level would fit the aging hypothesis of radiobiology. The results are considered as the first behavioral support for the radiobiological theory of aging. (BBB)

81 CHRONIC EFFECTS OF IONIZING RADIATIONS AND THE HYPOTHESIS THAT IRRADIATION PRODUCES AGING-LIKE CHANGES IN BEHAVIOR. Roger T. Davis (Univ. of Oregon, Eugene). J. Genet. Psychol., 102: 311-24(June 1963).

Two groups of old monkeys, one group surviving radiation, the other group nonirradiated, were compared for changes in behavior accompanying aging. The 17 rhesus monkeys used as subjects in these experiments consisted of two groups, each comprised of 6 monkeys aged 8.0 to 9.0 yr, and survivors of another group which had received 1100 r of whole-body x rays in 3 doses of 400, 400, and 200 r spaced at yearly intervals. Subjects were trained in a Wisconsin General Test Apparatus (WGTA). The first experiment involved giving old irradiated and nonirradiated monkeys and young nonirradiated monkeys concurrent discrimination problems in a modified retroactive inhibition paradigm. In the 2nd experiment the technique of substituting less for more preferred rewards during intratrial delays was used to test the frustrative effects of substituting inferior rewards or eliminating rewards within trials. The third investigation was designed to determine whether monkeys could learn to shift set, and whether previously irradiated and nonirradiated monkeys could shift with equal facility. In all these experiments only

one finding in any way supported the hypothesis that chronic effects of radiation mimic aging effects. This was the superiority of the performance of the control group over the performance of subjects with a radiation history in original learning of concurrent discrimination problems in Experiment I. There were, however, several differences between the two groups of old animals not related to the hypothesis on aging, and all of these differences appear consonant with the known changes in behavior of monkeys following irradiation. These negative findings, together with the previous negative findings of the effects of irradiation on learning, suggest that the syndrome caused by irradiation is dissimilar both to the syndrome resulting from aging and the syndrome caused by circumscribed lesions of the central nervous system. The features seen in monkeys irradiated with either whole-body or cortical irradiation are motivational and perceptual. It is concluded that differences between the groups did not suggest that aging-like changes are the chronic consequences of radiation. (BBB)

82 DEVELOPMENT OF DNA-SYNTHESIZING ENZYMATIC ACTIVITIES IN SOME ORGANS OF THE RAT AFTER X IRRADIATION. Monique Jacob, Pierre Chambon, and Paul Mandel (Institut de Chimie Biologique, Faculte de Medecine, Strasbourg). J. Physiol. (Paris), 53: 373-4(Mar.-Apr. 1961). (In French)

An earlier study attributed the presence of free nucleotides in irradiated spleen of rats to radiosensitivity of the DNA polymerase in that tissue. In the present experiment, rats were exposed to 700-r whole-body x irradiation and DNA polymerase activity was assayed (using as a substrate P^{32}-containing nucleotides for measuring DNA synthesis) in spleen, thymus, and testes. Measurements at 12 hr, 2, 4, and 7 days, revealed the following percentage inhibition: spleen 25, 42, 57, 114%; thymus 61, 79, 67, 35%; and testes 0, 0, 20, --%. The in vivo synthesis of DNA in spleen tissue was inhibited by 55, 70, 50, 0%. It was concluded that other factors than the direct x-ray inhibition of DNA polymerase are involved in the postirradiation reduction of DNA synthesis. Other experiments showed that DNase and nucleoside kinase activities are not reduced following irradiation. (BBB)

83 A NOTE ON INDUCED STERILITY IN MINK. Ole Venge (Royal Agricultural Coll. of Sweden, Uppsala). J. Reprod. Fertility, 5: 83-6(Feb. 1963).

In an attempt to induce mutations in mink, 30 males (Royal Pastel or Standard type) were exposed to x rays. The testes of three groups of 10 males each were irradiated one, two, or three times with a dose of 500 r at each treatment. The irradiation caused a very high degree of sterility in all three groups, and when the males were bred to nonirradiated females, a clear dose effect was observed. After 1500 r, no spermatozoa were found in the vaginal secretions immediately after copulation. The dose effect could also be seen from the histological results. In the 1500-r group, histological examination revealed extreme degeneration of spermatogenic tissue; spermatogonia, primary and secondary spermatocytes, and spermatids disappeared. In the 1000-r group a similar picture was seen. After 500 r, the damage was less drastic, but a high degree of degeneration was induced. Spermatozoa were found in the lumen in some tubules, but the number of spermatids was extremely low. The induced sterility seen here was very similar to the sterility in homozygous Stewart mink. The similarity between the histological preparations from Stewart mink and males in the present report receiving 1000 and 1500 r was striking, but in the Stewart mink the libido is not affected at all. It is concluded that irradiation of the testicles of mink at a dose of 500 r will cause a low fertility that is close to sterility. (BBB)

84 THE FROG'S EYE ELECTRORETINOGRAM AS AN IMMEDIATE X-RAY EFFECT. T. S. Veninga (State Univ., Groningen, Netherlands). Koninkl. Ned. Akad. Wetenschap, Proc., Ser. C, 64: 208-11(1961).

The electroretinogram (ERG) was recorded in the isolated, dark-adapted eye of Rana temporaria, and compared with the light-induced ERG, by the use of 45 kv x rays, the dose rate being varied by aluminum filters of appropriate thickness. With x-ray dose rates ranging from 2 to 67 r/sec it was possible to register an ERG which qualitatively had a similar shape as a normal light ERG. In most cases it clearly showed an on-effect (b-wave) and an off-effect (d-wave). With decreasing doses the height of the waves proportionally decreased. Sometimes only an on-response was noted using a dose rate of 50 r/sec, and successive reduction of the b-waves with time was observed. The fatigue phenomenon was always present if the interval between two stimulations was less than 1 min. With intervals >1 the amplitudes remained constant; this period appears to correspond to the time for complete recovery. Diminution of the amplitude with time continued until a min value was reached, the same stimulation now causing a further decrease. Complete disappearance of the waves was never seen, not even using the frequent stimulation cycle of 1 sec on and 1 sec off. In this case the amplitudes were all of the same height with the exception of the first one being much higher. Apparently, after the first stimulus an equilibrium sets in between the fatiguing effect and its recovery. If, after the amplitudes become constant, visible light of intensity was added during the period of observation, a new decrease of the height occurred. The reverse could be demonstrated too; i.e., an ERG induced by light could be reversibly attenuated by x irradiation. A more striking effect of x irradiation on the light ERG was demonstrated when a small light intensity was used; with increasing light intensities the x-ray inhibition of the light ERG decreased. The d-wave of the x-ray ERG, if present, generally varied similarly to the b-wave. However, its decrease was not as obvious because of the much lower amplitude of the d-wave. The influence of x rays on the off-effect in the light ERG was different. In 16 out of 30 experiments a slight increase was noted, in 10 a decrease of the height, and in the remaining 10 no effect. It is concluded that an x-ray ERG can be recorded with small doses of x rays. (BBB)

85 SEXUALITY AND RADIOSENSITIVITY. Med. Periskop (Ingelheim), 11: 119-20(Sept. 1961). (In German)

The influence of gonadectomy and of estrogen or androgen treatment on sensitivity to ionizing radiation is discussed. (BBB)

86 RADIATION INJURIES OF THE BONE TISSUE. D. A. Mikeladze (Tbilissi Medical Inst. for Graduate Studies, USSR). Med. Radiol., 8: No. 8, 35-42(Aug. 1963). (In Russian)

Investigations were made on late radiation injuries of bones (ribs, femur) with the aid of roentgenological and histological methods. Experiments were staged on 107 rabbits in which the ribs and upper third of the right femur were subjected to a single dose of 6000 r irradiation. Roentgenological and histological investigations disclosed that late radiation injury of the bone tissue by its manifestation and course is of dystrophic nature and steadily progressing it never undergoes reverse development. Dynamic studies were carried out for a period ranging from 1 to 12 months relative to the development of osteoporosis

and atrophy of the irradiated bone, fibrous replacement of the bone substance and bone marrow, the formation of necrotic bone foci, reorganization of trabeculae, and structural changes of cellular elements of the bone marrow. (P.C.H.)

87 ON THE RELATION BETWEEN CHANGES OF THE ARTERIAL PRESSURE AND THE STATE OF SOME REGULATORY MECHANISMS AT EARLY PERIODS FOLLOWING X-RAY IRRADIATION. A. N. Lanin (Central Inst. for Research in Medical Radiology, USSR). Med. Radiol., 8: No. 8, 42-8(Aug. 1963). (In Russian)

Studies of early changes of the arterial pressure in rabbits following whole-body x irradiation established that the nature and extent of the alterations depend upon the time lapse after the action of radiation, as well as on the dose of radiation and its time distribution. In animals subjected to 600 and 1800 r for a period of 30 minutes an increase in the arterial pressure 20 minutes after irradiation was observed. Animals subjected to similar doses for a period of 100 minutes showed 20 minutes after the irradiation a drop of the arterial pressure, which was proportional to radiation dose. Phasic changes of the arterial pressure at early periods following irradiation depend on functional disturbances of regulatory mechanisms: an elevation of the arterial pressure is associated to a certain extent with the reaction of the sympathetic region, whereby a decrease is associated with the predominant influence of the parasympathetic region of the vegetative nervous system. (auth)

88 ON THE HUMORAL COMPONENT DURING THE EFFECT OF BONE MARROW TRANSPLANTATION IN DOGS WITH ACUTE RADIATION SICKNESS. Tzun-hsien Chang (Inst. of Hematology and Blood Transfusion, USSR). Med. Radiol., 8: No. 8, 48-53(Aug. 1963). (In Russian)

In experiments staged on 9 dogs subjected to x irradiation (600 r) it is shown that the intravenous administration of a suspension of myeloid cells destroyed by repeated freezing 2 days after irradiation exerts a stimulating action on hematopoiesis and alleviates the severity of radiation sickness. This effect is explained by the presence of a humoral stimulating factor in the suspension, inasmuch as with the aid of a number of methods it was established that the suspension does not contain any viable cells of the red, white, and lymphoid series, capable of repopulation in the recipient's organism. The nature of the stimulating factor is not known. (auth)

89 THE INFLUENCE OF WHOLE-BODY ALPHA-IRRADIATION ON THE INDUCTION OF LIPOLYTIC ENZYMES BY CONNECTIVE TISSUE CELLS. F. L. Leites (Central Inst. of Physiotherapy, USSR). Med. Radiol., 8: No. 8, 54-8(Aug. 1963). (In Russian)

By means of the histochemical method, the influence of whole-body alpha-irradiation (one-month-long daily administration into the stomach of albino rats of radon water – 0.01 μC in the first series and 0.005 μC in the second series, comprising 0.05–0.025 μC/kg of body weight) on the induction of lipolytic enzymes by connective tissue cells was investigated. The experiments were carried out on a model of cholesterol granuloma. The radiation doses absorbed by the animals during the experiments comprised 0.25 ber in the first series and 0.125 ber in the second. It was found that in a greater as well as in a lesser absorbed radiation dose there occurs a considerable and statistically significant (in comparison with control–administration into the stomach of drinking water) stimulating action of alpha irradiation on the induction of lipolytic enzymes–nonspecific esterase and lipase–by cells of the cholesterol granuloma. This confirms the beneficial effect of alpha therapy on the lipoid metabolism in the organism. (auth)

90 THE CAUSES OF UNSUCCESSFUL ANTIBIOTIC THERAPY OF AUTOINFECTION IN RADIATION SICKNESS. I. D. Meter. Med. Radiol., 8: No. 8, 58-65(Aug. 1963). (In Russian)

The action of streptomycin and other antibiotics and chemotherapeutic preparations on the survival and autoinfection processes of irradiated mice was studied. Streptomycin proved to be most effective in a small range of doses and early terms of its employment. In streptomycin therapy a decrease of the level of bacteriemia and septicemia occurred in the irradiated animals, resulting in 85% survival of previously doomed animals. The causes hindering the effectiveness of antibiotic therapy of radiation autoinfection are: altered nature of bacterial flora in mice under the influence of treatment, the presence and more rapid development of resistant forms of bacteria in the irradiated organism, death of animals due to nonbacterial causes, with a particularly large number thereof in high doses of ionizing radiation. A combination of streptomycin with cortisone yielded promising results in the treatment of radiation sickness. (auth)

91 EFFECTS OF ATOMIC RADIATION. Borge Chr. Christensen. Medd. Sundhedsstyr., 122: 901-4 (Dec. 14, 1962). (In Danish)

Radiobiologic effects are briefly reviewed. (BBB)

92 COMPARATIVE RADIOSENSITIVITY OF ANIMAL ORGANISMS AND COPPER CONTENTS. Jack Schubert (Universidad, Buenos Aires). Nature, 200: 375-6 (Oct. 26, 1963).

A review is presented on the hypothesis that a correlation between radiosensitivity expressed as the $LD_{50/30}$ radiation dose killing 50% of an animal population within 30 days and the copper content of the animal. Calculations of radiation dose necessary to completely destroy the ability of (Cu_m) in animals to react with molecular oxygen are given. (P.C.H.)

93 POSSIBLE ROLE OF COPPER IONS IN RADIOBIOLOGICAL DAMAGE. M. Anbar (Weizmann Inst. of Science, Rehovoth, Israel). Nature, 200: 376(Oct. 26, 1963).

Findings that relate to the role of copper ions in radiobiological damage are reviewed. It is felt that the findings have a strong bearing on the mechanisms of radiobiological damage. A mechanism is suggested that may presumably account quantitatively for certain radiobiological phenomena. (P.C.H.)

94 GASTROINTESTINAL LEAKAGE OF ALBUMIN FROM IONIZING IRRADIATION. G. Birke, S. O. Liljedahl, L. O. Plantin, and J. Wetterfors (King Gustaf V Research Inst., Stockholm). Nord. Med., 67: 397-402(Mar. 29, 1962). (In Swedish)

Catabolism and extravasation of I^{131}-labeled serum albumin into the gut lumen were studied in rabbits exposed to whole-body doses of 275 to 1600 r γ radiation. For albumin catabolism and distribution, four different reaction patterns were seen, depending upon the dose. An effect noted at all the dose levels, however, was an elevated rate of albumin breakdown and a pathologically increased gastrointestinal leakage, which was correlated with the dose. With a low dose this was the only disturbance recorded. With a medium dose (about LD_{50}) there was, in addition, a more rapid initial distribution of albumin before gastrointestinal leakage reached full extent. This was interpreted as capillary damage, possibly of a general type. At a higher radiation

dose (exceeding LD_{50}), two different types of reaction were noted. At the highest dose level (1600 r) there was a marked extravascular distribution of albumin and the animals died after five days, nearly 50% of the retained activity in the body appearing in the gastrointestinal wall and, chiefly, in the contents of the stomach and intestine. In animals that received 1200 r there was initially the same increased extravascular distribution, but on the last days preceding death a high urinary excretion of radioactivity occurred simultaneously with a distinct reduction of extravascularly distributed albumin. When the animals died after eight days, 20% of the retained activity appeared in the digestive tract. (BBB)

95 STUDIES ON THE EFFECTS OF X-RAY IRRADIATION ON THE AREA OF THE MIDBRAIN AND THE PITUITARY GLAND. REPORT I. Toshiaki Murano (Osaka City Univ.). Osaka Shiritsu Daigaku Igaku Zasshi, 12: 1-9 (Feb. 1963). (In Japanese)

Biological effects of x irradiation to the area of the midbrain and the pituitary gland were studied in rats. The depth dose of x rays at the pituitary gland was almost the same as the surface dose. X irradiation at a dose of over 30 r resulted in a decrease of ascorbic acid and cholesterol, but an increase in phospholipid in the adrenal gland. As a result, the level of blood sugar was raised and glycogen level in the liver fluctuated. X irradiation in large doses (over 500 r) reduced urine excretion. It is assumed that the anterior lobe of the pituitary gland is affected by small doses of x rays and the posterior lobe is affected by large doses. (auth)

96 STUDIES ON THE EFFECTS OF X-RAY IRRADIATION ON THE AREA OF THE MIDBRAIN AND THE PITUITARY GLAND. REPORT 2. Toshiaki Murano (Osaka City Univ.). Osaka Shiritsu Daigaku Igaku Zasshi, 12: 11-17(Feb. 1963). (In Japanese)

Biological effects of x irradiation to the area of the midbrain and the pituitary gland were studied in rats. The depth dose of x rays at the pituitary gland was about half of the surface dose. X irradiation in large doses (over 500 r) increased the level of antidiuretic substance in blood plasma and accelerated an excretion of bile. Pitressin promoted an excretion of the bile, while Atonin-O failed to promote it. (auth)

97 ON THE QUALITY OF X-RAY USED IN THE RADIOBIOLOGICAL STUDIES. Haruma Yoshinaga, Shigetoshi Antoku, Keiko Tanaka, and Yaeko Oku (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, 11-22(1961).

The measurement of the attenuation rate in phantoms, of the depth dose ratio in animals, and the calculation of the absorbed dose from the energy distribution were carried out with x rays used in animal experiments. The attenuation rate and absorption coefficient in phantoms did not significantly change with change of radiation quality, except for 160 Kvp and 180 Kvp x rays with a 0.3-mm Cu + 0.5-mm Al filters. The depth dose ratio of the lower abdominal cavity of rat and rabbit had essentially the same tendency as described for the phantom experiments. The difference in mean absorbed dose obtained from the energy distribution was 2 to 3% in water and muscle and about 50% in bone with 9 kinds of radiation quality used in the experiments. (auth)

98 DEATH TENDENCY OF EXPOSED CHILDREN. Kazuhiro Miki (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima J. Med. Sci., 8: 351-416(Dec. 1959)).

Results are reported from a statistical study on the life span, neoplastic diseases, infectious and other diseases, death rate, and sex differences in children of Hiroshima exposed to radiation from the atomic bomb at various distances from the hypocenter. The exposed group and control group were divided into groups of those exposed in utero, within 7 days after birth, up to 1 yr of age, up to 5 yr of age, and school age above 5 yr. The death rate of children exposed in utero and after birth was higher than that of the control group, the incidence of neoplastic and circulatory diseases was greater in those exposed after birth than in control groups, and the direct effects of radiation exposure were evident for 3 yr in those exposed after birth. (C.H.)

99 STUDIES ON THE ADRENAL CORTEX-FUNCTION OF THE ATOMIC BOMB SURVIVORS IN OTAKE. Keigo Ishii (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, Spec. Vol., 13: 443-62(1960)).

100 SERUM IRON DETERMINATION OF NAGASAKI ATOMIC BOMB SURVIVORS. Bunro Watanabe, Yasuro Kamochi, Noboru Ozono, and Masanobu Tomonaga (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Kyushu Ketsueki Kenkyu Dokokai-shi, 10: 616-19(Nov. 1960)). (In Japanese)

Blood serum Fe was measured in Nagasaki atomic bomb survivors during Aug. and Sept., 1957. They were classified into anemic and nonanemic groups and also classified according to distance from the bomb hypocenter and major radiation symptoms following exposure. No significant difference in blood serum Fe attributable to radiation dose was found. (C.H.)

101 ENZYMOLOGICAL STUDIES IN STOMATIC REGIONS OF THE PATIENTS EXPOSED TO ATOMIC BOMB. Toru Shibata (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, Spec. Vol. 13: 755-69(1960)). (In Japanese)

102 THE STATISTICAL STUDY OF STILLBIRTH. CHAPTER 1. INVESTIGATION BY THE REPORT OF A BIRTH AND OF A STILLBIRTH IN HIROSHIMA CITY. Shigesue Ishizu (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 1063-78(1960)). (In Japanese)

103 THE STATISTICAL STUDY OF STILLBIRTH. CHAPTER 2. INVESTIGATION ON A STILLBIRTH OF EXPOSED WOMEN BY A HOUSE TO HOUSE VISIT. Shigesue Ishizu (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 1079-1105(1960)). (In Japanese)

104 PATHO-HISTOLOGICAL STUDIES ON THE MODE OF THE DEVELOPMENT OF LEUKEMIA, ESPECIALLY ON LEUKEMIA IN ATOMIC BOMB SURVIVORS. Ikuso Horino (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 1137-79(1960)). (In Japanese)

105 HISTO-PATHOLOGICAL STUDIES ON THE EFFECTS OF INTERNAL IRRADIATION WITH BETA-EMITTING ISOTOPES (^{32}P, ^{89}Sr, AND ^{144}Ce) ON THE GASTROINTESTINAL TRACT OF MICE. Minoru Kamimatsuse (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2,(1961). (Reprinted from Hiroshima Igaku, 8: 2131-9(1960)).

The pathological effects of β particles on the gastrointestinal tract of mice were studied after single and repeated intravenous intraperitoneal, or oral doses of P^{32}, Sr^{89}, or Ce^{144} varying from 0.5 to 5.0 $\mu C/g$. Histological findings of pathological effects are described. (C.H.)

106 PATHO-MORPHOLOGICAL STUDIES ON THE EFFECTS OF INTERNAL IRRADIATION WITH RADIOISOTOPE ^{131}I IN MICE, ESPECIALLY ON THE CHANGES OF THE PITUITARY BODY AND HEMATOPOIETIC ORGANS. Hiroyuki Takemoto (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 2269-2300(1960)).

Results are reported from histological studies of the pathological effects of intravenous doses of 1, 3, or 5 $\mu C/g$ of I^{131}, administered as one dose or in 10 divided doses, on the thyroid gland, pituitary gland, and hematopoietic tissues in mice. (C.H.)

107 HISTOPATHOLOGICAL AND HEMATOLOGICAL STUDIES ON THE EARLY EFFECTS OF A SINGLE TOTAL BODY X-IRRADIATION ON THE HEMATOPOIESIS IN MICE, RATS AND GUINEA PIGS. Yotaro Honda (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 8: 3999-4034(1960)). (In Japanese)

The effects of whole-body exposure to x radiation doses of 350 r in mice, 350 r in young rats, and 180 to 200 r in young guinea pigs on the blood picture were followed for 90 days following irradiation. Phosphorus-32 was used as a tracer in studies of spleen metabolism. Both medullary hematopoiesis in various bones and extramedullary hematopoiesis in the spleen were correlated with histological evidence of radiation injury. It was concluded that the increase in spleen weight beyond normal that was observed to reach a peak 20 days post-irradiation was due to the vigorous acceleration of extramedullary hematopoiesis. This response was considered to be compensatory in nature in view of the inadequacy of bone marrow hematopoiesis during this period, and it was concluded it was responsible for the sudden increase in neutrophils observed in peripheral blood at this time. (C.H.)

108 MORPHOLOGY AND HATCHING POWER OF THE DEVELOPING CHICK EMBRYO FOLLOWING X-IRRADIATION. R. E. Moreng and K. W. Hollister (Colorado State Univ., Fort Collins). Proc. Soc. Exptl. Biol. Med., 114: 99-103(Oct. 1963).

Single dose, whole-body x irradiation of Single Comb White Leghorn embryos from 0 through 13 days of development resulted in an increased incidence of morphological abnormalities similar to those commonly observed among embryos of the domestic fowl. The two highest doses, 200 and 300 r above the previously determined LD_{50}, were responsible for the majority of the abnormalities which included midgets, foot and leg deformities, and abnormal mandibles. Hatching percentage of treated embryos decreased as the dose increased; no apparent relation existed between hatching weight and dose received. (auth)

109 BACTERICIDAL ACTIVITY OF FIXED PHAGOCYTES IN IRRADIATED AND UNIRRADIATED MICE TREATED WITH RNA. Carolyn W. Hammond (Univ. of Illinois, Chicago). Proc. Soc. Exptl. Biol. Med., 114: 213-15(Oct. 1963).

CF1 female mice 9 to 10 weeks old were injected intravenously with RNA 30 min before or on the 4th day after exposure to a sublethal dose of x irradiation (550 r). Simultaneously an equal number of irradiated mice were injected intravenously with buffered saline to serve as controls. On the 5th day post-irradiation all mice were injected intravenously with Ps. aeruginosa followed 1 min later by intravenous polymyxin or colymycin. The next day all mice were killed and heart's blood cultured. Livers and spleens were removed, ground separately in tissue grinders and appropriate dilutions plated. The results of the bacterial counts indicated that the mean number of pseudomonads in livers and spleens of mice injected with RNA were slightly lower than the mean number in livers and spleens of controls but the difference was not significant. Similar results were obtained among unirradiated mice injected with RNA 4 days before challenge with Ps. aeruginosa. (auth)

110 EFFECT OF A SEROTONIN ANTAGONIST ON RADIATION LETHALITY. Robert N. Feinstein and John E. Seaholm (Argonne National Lab., Ill.). Proc. Soc. Exptl. Biol. Med., 114: 247-8(Oct. 1963).

The serotonin antagonist 1-(N-methyl-piperidyl-4')-3-phenyl-4-benzyl-pyrazolone-5 (KB-95) shows mildly protective effects against 600-r whole-body x irradiation in mice, if administered prior to irradiation. The compound exhibits a dose-reduction factor of approximately 1.1 in both rats and mice. (auth)

111 MYOCARDIAL INJURY IN THORACIC THERAPY. V. Michailov. Radiobiol. Radiotherap., 4: 423-8 (1963). (In German)

The results of experiments establishing the sensitivity of the myocardial cells to ionizing radiation, compared with clinical and autopsy findings, justify a new estimation of the radiosensitivity of the cardiac myofibrils. (auth)

112 GONADAL LOAD IN THE TREATMENT OF A HEMANGIOMA WITH THORIUM-X-LAC. A. Unverricht and K. Herrmann (Friedrich-Schiller-Universität, Jena, Ger.). Radiobiol. Radiotherap., 4: 459-63(1963). (In German)

Measurements of the gonadal load in the treatment of hemangiomas with thorium-X-lac in children are reported. Measurements were taken both on the child and on a phantom. The γ dose values obtained vary between 100 mr and 10 r depending on the hemangioma-gonad-distance, surface size and time of irradiation. It becomes clear that owing to the gonadal load the use of radium-224 in the vicinity of the gonads must be rejected. (auth)

113 THYMUS: ITS LIMITED ROLE IN THE RECOVERY OF HOMOGRAFT RESPONSE IN IRRADIATED MICE. Marvin L. Tyan, Leonard J. Cole, and William E. Davis, Jr. (Naval Radiological Defense Lab., San Francisco). Science, 142: 584(Nov. 1, 1963).

Adult mice subjected to thymectomy or sham thymectomy received lethal irradiation and subsequent protective infusion of syngeneic bone marrow. Thirty days later they received allogeneic and xenogeneic skin grafts. Donors of the xenogeneic grafts were rats. The thymectomized mice rejected the grafts of rat skin only slightly later than the controls did; in contrast, the time of retention of allogeneic grafts was significantly longer in the thymectomized mice. (auth)

114 FURTHER ANALYSIS OF ELIMINATION OF RUNT DISEASE AND INDUCTION OF TOLERANCE BY X-IRRADIATED SPLEEN CELLS. Bertie F. Argyris (Syracuse Univ., N. Y.). Transplantation, 1: 488-94(Oct. 1963).

A quantitative estimate was made of the decrease in proliferative capacity and immunologic activity of spleen cells exposed to 400 r of total-body x irradiation. The decreased proliferative capacity of irradiated CBA spleen cells was inferred from a decreased ability to induce homograft tolerance in newborn C3H mice as compared to the ability of various doses of nonirradiated CBA spleen cells to induce homograft tolerance. The decreased immunologic activity of CBA spleen cells was estimated from a decreased capacity to induce a graft-versus-host reaction in newborn C57BL/6 mice as compared to the capacity of standard doses of nonirradiated CBA cells to elicit a

graft-versus-host reaction. The results indicate that 400 r of total-body x irradiation reduces the proliferative capacity of CBA spleen cells by about 95 to 96% and the immunologic activity by about 98 to 99%. (auth)

115 OBSERVATIONS OF THE PASSIVE TRANSFER OF TRANSPLANTATION IMMUNITY AND DELAYED HYPERSENSITIVITY WITH LYMPHOID CELLS IN MILLIPORE CHAMBERS. John S. Najarian and Joseph D. Feldman (Scripps Clinic and Research Foundation, La Jolla, Calif.). Transplantation, 1: 495-501(Oct. 1963).

Experiments were done to determine whether antigen or a transfer factor escaped from millipore chambers containing viable cells with subsequent immunization of the recipient mice. Homologous nonsensitized and isologous sensitized lymphoid cells enclosed in millipore chambers were transferred to recipient mice. After appropriate time intervals, the hosts were tested by skin homografts. There was no evidence that recipients were immunized by an escape from the chambers of homologous cells, of antigen carried over with sensitized cells, or of a transfer factor. In mice given 650 r total-body irradiation, a dose sufficient to prolong the MST of first-set grafts by 6 days, accelerated rejection of test skin homografts was achieved by lymphoid cells sensitized to homologous tissues and enclosed in millipore chambers. That leakage of cells might occur, but in numbers too small to effect immunization of the host, was indicated by the deaths of 5 of 53 recipients of virulent leukemia cells placed in chambers. In guinea pigs, tuberculin and contact chemical sensitivity could not be transferred by cells sensitized to tubercle bacilli or dinitrofluorobenzene and contained in cell-impenetrable millipore chambers. These data corroborated the conclusion that transplantation immunity on the one hand and tuberculin and contact sensitivity on the other hand are mediated by different immunologic mechanisms. (auth)

116 LETHALLY IRRADIATED DOGS GIVEN INFUSIONS OF FETAL AND ADULT HEMATOPOIETIC TISSUE. E. D. Thomas, J. A. Collins, S. Kasakura, and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Transplantation, 1: 514-20(Oct. 1963).

Lethally irradiated dogs, 1500 r, were given infusions of fetal hematopoietic tissue (16 dogs), adult marrow and fetal hematopoietic tissue (17 dogs), and adult marrow and adult spleen (8 dogs). The incidence of successful engraftment, graft injection, and secondary syndromes was found to be similar to that observed after adult marrow alone. It is concluded that in this species, as in the mouse, successful marrow engraftment and survival of secondary syndromes depend primarily on a choice of donor and recipient of reasonable histocompatibility. (auth)

117 PARABIOSIS INTOXICATION IN INBRED RAT PAIRS AND ITS MODIFICATION BY X-IRRADIATION. Robert T. Binhammer and Burton G. Must (Univ. of Cincinnati). Transplantation, 1: 552-61(Oct. 1963).

Parabiosis intoxication and its modification by x irradiation was investigated in inbred rat strains. Development of intoxication was followed by visual inspection and by taking microhematocrits from tail vein blood before parabiosis and on given days after pairing. Parabiotic groups consisted of Buffalo-Lewis, Lewis-LBF_1 (Lewis × Buffalo F_1), and Buffalo-LBF_1 strain combinations. Lewis rats were more prone to develop an early temporary anemia. Intoxication (anemia of one rat and polycythemia of the other) with fatality developed in most Buffalo-Lewis pairs. When LBF_1 animals were paired with either parent strain, anemia of intoxication was limited to the hybrid. In Buffalo-LBF_1 combinations all hybrid partners became severely anemic and mortality was complete. Total-body x irradiation (500 r) of Buffalo rats immediately before parabiosis with LBF_1 partners eliminated intoxication and resultant mortality. In pairs in which the hybrid partner was irradiated, anemia-polycythemia was initiated more rapidly and mortality was high. Irradiation of both partners reduced hematocrit changes but did not prolong survival. Intoxication was interpreted as an immune response of the parent against the hybrid; elimination of the syndrome by irradiation of the parent supports this hypothesis. (auth)

118 MARROW TRANSPLANTS IN LETHALLY IRRADIATED DOGS: THE EFFECT OF METHOTREXATE ON SURVIVAL OF THE HOST AND THE HOMOGRAFT. E. D. Thomas, S. Kasakura, J. A. Cavins, and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Transplantation, 1: 571-4(Oct. 1963).

Twenty dogs were given 1500 r whole-body irradiation and an infusion of homologous marrow. Ten dogs treated with methotrexate were compared with 10 dogs that received no drug therapy. The dogs given methotrexate showed an increased incidence of graft take, a decreased incidence of graft rejection, and an increased number of long-term survivors. (auth)

119 MOLEKULYARNAYA GENETIKA I DEISTVIE IZLUCHENII NA NASLEDSTVENNOST'. (Molecular Genetics and Radiation Effects on Heredity). N. P. Dubinin. Moscow, Gosatomizdat, 1963. 240p.

Problems in molecular genetics are analyzed, and radiation effects on molecular structures are discussed. Physical and chemical bases in heredity, decoding the genetic code, the molecular basis of albumen synthesis, controlled heredity, radiation effects on heredity in man, and other allied questions are reviewed. (R.V.J.)

120 ENZYMATIC AND MICROBIAL ACTIVITY IN RADIATION STERILIZED SOIL. John Janis Skujins. Thesis, Berkeley, Calif., Univ. of California, 1963. 121p.

Soil was treated with ionizing radiations of high intensities and potentials to obtain sterile soil having physical and chemical properties nearly like those of normal field soil. Such soil retained some enzyme activities. Different types of loam were treated with a beam of 5 to 9 Mev electrons, Co^{60} γ rays, and hard x rays to determine the influence of these irradiations on soil microbial population, on enzymatic (phosphatase) activity in soil, and on the suitability of irradiated soil for microbial culture under laboratory conditions. For a given soil the survival curves of aerobic and anaerobic bacteria with irradiation were almost superimposable; survival curves differ among soils. Bacterial numbers approach zero at 2×10^6 rep doses and those of fungi at 0.3×10^6 rep doses. To insure complete sterility, 4×10^6 to 5×10^6 rep doses were necessary for large soil volumes. This technique provides soil which can be studied in the absence of a microbial population, and also a medium for studying soil microorganisms. Such soils are also useful for growth of sterile plants without interference of microbes. (M.P.G.)

121 RADIATION AND RADIOMIMETIC CHEMICALS. COMPARATIVE PHYSIOLOGICAL EFFECTS. L. A. Elson. Cancer Monograph Series. Washington, D. C., Butterworths, 1963. 131p. $5.00.

The physiological effects of radiation and radiomimetic chemicals are compared. Results are reported from studies in man and laboratory animals, with studies in rats predominating. The effects of alkylating agents; antimetabolites, particularly folic acid antagonists; and miscellaneous chemicals, such as urethane, carcinogenic hydrocarbons, and aminostilbenes on body growth, tumor growth,

and hematological response are discussed and compared with the effects of radiation. (136 references) (C.H.)

122 EFFECTS OF IONIZING RADIATION ON THE DIGESTIVE SYSTEM. I. T. Kurtsin. Amsterdam, London, and New York, Elsevier Publishing Company, 1963. 335p. $16.00. Translated from Russian by Scripta Technica, Inc., Washington, D. C.

The symptoms of acute radiation injury are reviewed. It is pointed out that digestive disorders constitute a major factor in radiation sickness and also greatly complicate and aggravate the general course of the pathological processes and weaken resistance of the organism to infections and other complications of radiation sickness. It is stressed that radiation lesions of the viscera, including the digestive organs, are associated with pronounced symptoms of nervous disorders, especially in the higher divisions of the central nervous system. The prevention and treatment of radiation injury of the gastrointestinal tract depend on knowledge of the physiological mechanisms involved in the development of radiation injuries. Clinical observations on radiation lesions of the viscera and central nervous system are summarized. Data obtained from studies on 100 dogs with acute radiation sickness showed that hyperfunction of the digestive glands is almost as common as hypofunction in acute radiation sickness. Both direct and indirect effects of radiation on the digestive system are discussed. Emphasis is placed on radioinduced impairment of the secretory function of the salivary glands, stomach, pancreas, liver, and small intestine; and radiation effects on morphology of digestive glands and neural regulation of digestive functions. (375 references) (C.H.)

123 COMPARISON OF EFFECTS OF D_2O AND X-RAY IRRADIATION ON LIPID COMPOSITION OF TISSUE CULTURE CELLS. George H. Rothblat, Richard W. Hartzell, Jr., and David Kritchevsky (Wistar Inst. of Anatomy and Biology, Philadelphia). Vienna, International Atomic Energy Agency, 1963, Preprint SM-50/37, 16p. (CONF-269-1)

From International Atomic Energy Agency Symposium on Isotope Mass Effects in Chemistry and Biology, Vienna, Dec. 1963.

Studies of two different tissue culture cell lines (L5178Y and MK) grown in medium containing 20 to 30% D_2O show the following as compared with control cells increased generation time; increased cell size; increased total lipid content; increased cholesterol ester and total glyceride, the glyceride increase being primarily in the triglyceride fraction; little or no change in free cholesterol; and no change in phospholipid. X irradiation (2000 r) of the MK cells resulted in increased cell size and total lipid with major lipid changes being increased squalene, cholesterol ester, and monoglyceride; no changes in free cholesterol, diglyceride and phospholipid, and a drop in triglyceride content. (auth)

Radiation Effects Therapy and Countermeasures

124 (HW-SA-3188) A COMPREHENSIVE STUDY OF THE EXCRETION RATES OF Pu-239 FOLLOWING A PLUTONIUM-CONTAMINATED INJURY. F. Swanberg, Jr. and R. C. Henle (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 9, 1963. Contract AT(45-1)-1350. 26p. (CONF-279-2)

From 7th Annual Western Industrial Health Conference, San Francisco, Sept. 1963.

Contaminated minor injuries are to be expected in large scale Pu manufacturing operations. Early medical treatment to reduce the retention of radioactive materials can be achieved by a close working team of medical and radiation protection specialists. Chelating agents with the resultant elevated excretion rates of Pu make the assessment of the body burden difficult. Treatment may effect excretion rates for as long as 200 days after administration of DTPA requiring long-term follow-up study of such cases. The fecal excretion rate of Pu after the initial course of treatment is influenced much less than the urinary excretion rate by subsequent treatment with chelating agents. A comprehensive case history is presented of a Pu-contaminated minor injury. The incident is described and the medical treatment, urinary and fecal excretion data, and evaluation of the body burden are presented. (C.H.)

125 SOME ASPECTS OF SYNERGISTIC ACTIONS OF HALOGENOPHENOLS ON RADIATION LETHAL EFFECT. Mitsuo Namiki, Akira Matsuyama, Yoshishige Okazawa, and Ichiro Kaneko (Inst. of Physical and Chemical Research, Tokyo). Agr. Biol. Chem. (Tokyo), 27: 358-65(May 1963).

Data concerning synergistic actions of halogenophenols to increase the radiation lethal effect on E. coli are presented. The synergistic actions of these reagents were greatly depressed by the addition of certain organic materials or freezing during irradiation. These results suggest that indirect actions of ionizing radiations may play an important role in the halogenophenol actions. After-effects of the irradiated reagents were also observed and the magnitude of significance of the after-effect appeared to be varied with difference in chemical structures of halogenophenols. Discussions concerning their mode of action and mechanism of the enhancement are given. It was postulated that their synergistic effects during irradiation may be due to the actions of short-life free radicals and long-life species produced by the radiolysis of halogenophenol and also to some radiation damages within cells. (auth)

126 EFFECT OF CHEMICAL MODIFIERS ON INACTIVATION AND MUTATION-INDUCTION BY GAMMA RADIATION IN ESCHERICHIA COLI. B. A. Bridges (Medical Research Council, Harwell, Berks, Eng.). J. Gen. Microbiol., 31: 405-12(June 1963).

In continuation of earlier studies demonstrating sensitization by N-ethylmaleimiede (NEM) and of protection by dimethyl sulfoxide and thiourea when inactivation of colony-forming ability was the criterion of radiation damage, the influence of these compounds, together with the familiar modifiers oxygen, glycerol and cysteine, was investigated using an additional criterion of radiation effect, namely mutation. Reversions to tryptophan independence in strain WP 2 of E. coli B/r were studied. Cobalt-60 γ radiation was given at room temperature in a glass vessel at the rate of 4500 rad/min; air or oxygen-free nitrogen was bubbled through the bacterial suspension for 6 min before and throughout irradiation. Neither NEM nor oxygen had any effect on the spontaneous mutation rate, but they enhanced both radiation-induced mutation and inactivation. For inactivation the enhancement ratios, based on slopes of survival curves, were greater for oxygen and for NEM + oxygen (which were identical) than for NEM alone. When the enhancement ratios were based on the doses needed to produce a given effect (e.g. G = 300), it appeared that the mutation enhancement ratio for oxygen + NEM was significantly less than that for oxygen alone, and that treatment with NEM + oxygen was not strictly dose-modifying. It is

suggested that a constant small proportion of mutants is not expressed when NEM is present under aerobic conditions. When all the protective agents were tested under conditions of strict anoxia, thus eliminating oxygen-depletion as a cause of apparent protection, none of the chemicals tested affected the spontaneous mutation rate. With the possible exception of cysteine, the treatments were not dose-modifying; protection was shown only at doses greater than 10-15 krad. With glycerol, for example, this threshold effect was shown whether the compound was added 6 or 26 min before irradiation, indicating that the threshold is not due to a requirement for preincubation with the compound. Glycerol, cysteine, and thiourea protected against mutation-induction and inactivation to the same extent, whereas dimethyl sulfoxide was appreciably less efficient at protecting against mutation-induction than against inactivation. It was shown previously that NEM enhances the lethal action of radiation only when present during irradiation; in this respect it resembles oxygen. It is suggested that NEM and oxygen are both able to combine with reactive sites which appear during irradiation on important biological molecules. The sites which react with oxygen are not known but it is suggested that those which react with NEM might be -SH groups or -S free radicals. Thus, proteins must be intimately involved in sensitization, and hence in mutation, since they are the only large sulfur-containing molecules of importance to the cell. The present results are difficult to reconcile with this hypothesis of mutations arising as a result of changes in DNA. In contrast to the specificity of sensitization, chemical protection seems to be a fairly uniform and general phenomenon and largely independent of the nature of the targets, as seen by these results with thiourea, glycerol, and cysteine. With dimethyl sulfoxide, however, significantly less protection was afforded against mutation-induction than against inactivation; it may have difficulty in penetrating sufficiently near to the locus which determines tryptophan-dependence. (BBB)

127 MICROBIOLOGICAL METHODS FOR TESTING RADIOPROTECTIVE AGENTS. F. Hernadi, A. Rencz, A. Jeney, and T. Valyi-Nagy (Univ. Medical School, Debrecen, Hungary). Kiserl. Orvostud., 13: 613-17(1961). (In Hungarian)

A method is presented whereby potential radioprotective compounds may be assayed for activity in irradiated cultures of Escherichia coli 0111 and Streptomyces bikiniensis. The sensitivity of this method allows 1 to 100 μg of a compound to be tested. (BBB)

128 PROTECTIVE CHEMICAL COMPOUNDS AND THEIR MECHANISM OF ACTION IN IRRADIATED ANIMALS. Blahoslav Zicha (Veterinarni Vyzkumne Stredisko, Prague). Lekarska. Veda Zahranici, 6: 121-44(June 22, 1962). (In Czech.)

Literature reporting the testing of several hundred compounds for radioprotective activity is extensively reviewed with the citation of 313 references. (BBB)

129 BIOCHEMICAL EFFECTS OF X-IRRADIATION AND THE SULPHYDRYL HYPOTHESIS: A RE-APPRAISAL. Margery G. Ord and L. A. Stocken (Oxford Univ.). Nature, 200: 136-8(Oct. 12, 1963).

Attempts were made to relate directly the alterations in SH content of thymus nuclei to known changes in nuclear metabolic post-irradiation. Oxidized glutathione (GSSG) was used to reproduce the oxidative effects of x irradiation on nuclear sulfhydryl groups. Oxidized glutathione was found to reduce the activity of glucose-6-phosphate dehydrogenase and inhibit the formation of labile phosphate. The inhibitory effect of GSSG on nuclear phosphorylation suggests either that the formation of ATP in thymus nuclei is associated with an oxygen-dependent oxidation of NADPH, or that the disulfide has reduced phosphorylation by interaction with some SH groups essential for the reaction. Interpretation of the results is discussed. (P.C.H.)

130 HISTOPATHOLOGICAL AND HEMATOLOGICAL STUDIES ON THE EFFECT OF ESSENTIAL AMINO ACIDS ON HEMATOPOIESIS IN X-IRRADIATED MICE. Hiroshi Fukuma (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, (1961). (Reprinted from Hiroshima Igaku, 9: 765-801(1961)). (In Japanese)

The effect of injections of 0.1 cc of essential amino acids subcutaneously for 20 successive days on hematopoiesis in mice following exposure to x-ray doses of 350, 500, or 600 r was studied. Blood tests were done periodically for 60 days after exposure. The injected amino acids exerted a protective effect on hematopoiesis after exposure to doses of 350 or 500 r but had no effect on the life span of those exposed to 600 r. Histological studies of hematopoietic tissues were made at various intervals. It was concluded that the injected amino acids inhibited increased capillary permeability that occurs in the early stages following irradiation and also accelerated protein synthesis and promoted regeneration of hematopoietic tissues. (C.H.)

131 THE INFLUENCE OF HEMATOLOGICAL RADIATION INJURY OF NEWBORN MICE BY PREMEDICATION WITH "LYSOPAR" AND AET. H. Fischer (Universitäts-Geschwulstklinik der Medizinischen Fakultät, Berlin). Radiobiol. Radiotherap., 4: 443-57(1963). (In German)

Investigations on the effect of liver-hydrolysate, Lysopar, and the chemical protective substance AET on the induced radiation injury in the peripheral blood of newborn mice showed that the parallel course of erythrocyte and leukocyte reaction could not be influenced. The erythrocyte counts are in the maximum depression significantly above the values of the unprotected irradiated mice. The reticulocyte decrease cannot be stopped, the regeneration however is intensified under the protective action. The leukocyte reaction could not be influenced either by AET or by Lysopar. (auth)

Radiation Hazards and Protection

132 (BNL-941) EVALUATION OF PLUTONIUM EXPOSURES IN MAN. J. S. Robertson and S. H. Cohn (Brookhaven National Lab., Upton, N. Y.). May 25, 1963. Contract [AT(30-2)-Gen-16]. 46p.

A substantial number of people are employed in the processing of Pu and, despite the use of protective equipment, some of these people excrete detectable quantities of Pu. It is assumed that the Pu enters the body via the respiratory route. Extensive animal studies and the available human data indicate that Pu that reaches the circulation becomes deposited chiefly in the skeleton and liver, with the skeleton being the critical organ because of its role in the induction of osteogenic sarcoma and other bone lesions. Recent studies in dogs indicate that the lung retention half time may be a year or longer, depending on the particle size, and that 70 to 90% of the inhaled dose may be in the lungs or associated structures. It is pointed out that excretion values do not provide reliable information on lung burdens. Methods of estimating body burdens of Pu are re-

viewed. The advantages and disadvantages of whole-body counting are discussed. (74 references.) (C.H.)

133 (NLCO-895) A CONTINUED PROGRAM OF ANALYSIS FOR URANIUM IN HUMAN AND ANIMAL TISSUES. Richard C. Heatherton, Michael W. Boback, and Joseph A. Quigley (National Lead Co. of Ohio, Cincinnati). Sept. 20, 1963. Contract AT(30-1)-1156. 13p. (CONF-212-3)

From 9th Annual Bioassay and Analytical Chemistry Conference, San Diego, Oct. 1963.

Five case studies of persons with histories of chronic exposure to airborne U are reported. Comparisons are made of U concentrations found in tissues of exposed and unexposed persons. Also reported are concentrations found in organs of small animals taken within the environs of a U plant. Reasons are suggested for the relatively small concentrations of U in the tissues of the exposed workers. A critical review of the work that has been done and suggestions for future work are included. (auth)

134 THE PROBLEM OF IONIZING RADIATIONS. G. Montano. Gac. Med. Mex., 93: 1-3(1963). (In Spanish)

Hazards of radiation in medical applications are discussed. (BBB)

135 EXPERIENCE WITH THE PROTECTION OF WORKERS IN ROENTGENOLOGIC DEPARTMENTS FROM INJURIOUS EFFECTS OF ROENTGEN RAYS. Karoly Dosay (National Roentgen and Radiation Inst., Budapest). Magy. Radiol., 13: 46-51(Jan. 1961). (In Hungarian)

Problems encountered in connection with x-ray procedures employed at the National Roentgen and Radiation Institute are discussed. The protective measures used in the various establishments throughout Hungary are reviewed and the most serious hazards detected are pointed out. Preliminary results of measurements on monitoring film badges worn by roentgenologic personnel are reported. (BBB)

136 EXPOSURE OF THE BASE OF THE BRAIN TO ROENTGEN RAYS DURING EPILATION OF THE SCALP. Jozsef Vegh and Istvan Nikl (MAV Hospital & Central Dispensary, Budapest). Orv. Hetilap, 102: 1077-81(June 4, 1961). (In Hungarian)

The advisability of epilation of the scalp in one or two sessions is questioned. It is pointed out that the brain receives sufficient radiation in such cases to cause neurologic damage. Patients so exposed almost without exception showed nausea, vomiting, fever, restlessness, dizziness, loss of appetite, and visual disturbances. Subsequent tests showed that in certain instances the intelligence and discriminatory functions of the brain were unfavorably influenced. To evaluate this problem, dosimetry studies were conducted on a phantom. A female skull was prepared so that the soft tissues were represented by a paraffin mass. The epilation procedure was conducted on this skull at various x-ray intensities (43, 50, 80, 120 kv), testing various areas of the skull at the same intensity. Condensation-ionization chamber measurements showed that at 80 kv the pituitary region received almost four times (778-913 r) the dose than if 43 kv were used (208 r). It is recommended that the brain damage would be reduced and the undesirable symptoms thus eliminated if the epilation of five scalp areas was carried out over a 10- to 12-day period with a 1-day interval between each radiation session. The treatment of children under 5 yr of age should be fractionated in even smaller doses. (BBB)

137 HEALTH HAZARDS OF ATOMIC RADIATION. M. L. Du Preez (National Physical Research Lab., C.S.I.R., Pretoria). Public Health (Johannesburg, 63: 7-20(Jan. 1963).

Health hazards from ionizing atomic radiation are reviewed, with reference to the part local health departments may play in the event of a nuclear explosion. Tables are given showing the probable effects on a human of a single large γ-ray dose over the whole body. It is estimated that the mean lethal dose for humans is about 450 r, i.e., that about 50% of a population receiving 450 r will die. On the other hand, a total-body dose of 75 r or more, will cause radiation sickness. Radiobiologic effects are described with particular regard to organs and tissues that are very sensitive to radiation: blood and bone marrow, the lymphatic system comprising the spleen and other tissues, skin and hair follicles, alimentary canal, adrenal glands, thyroid, lungs, eyes, and reproductive organs. The effects of radiation on each of these organs and tissue groups are briefly discussed. Genetic and carcinogenic actions of radiation are also considered. (BBB)

138 THE ATOMIC AGE AND THE PEDIATRICIAN. Lee E. Farr (Texas Univ., Houston). Quart. Rev. Pediat., 14: 118-19(Apr.-June 1959).

Responsibilities of pediatricians in the use of radiation and radioisotopes in diagnosis and treatment are briefly discussed. (BBB)

139 CESIUM-137 AND IODINE-131 IN FINNISH MILK FROM SEPT. 1962 TO AUG. 1963. Tauno Moisio and Jorma K. Miettinen (Biochemical Inst., Helsinki). Suomen Kemistilehti, 36B: 2p. (1963).

Milk from Helsinki, Joensuu, and Rovaniemi, Finland, was analyzed for Cs^{137} and I^{131} from Sept. 1962 to Aug. 1963. The maximum I^{131} content in milk was observed in Helsinki on Sept. 21, 1962. The Cs^{137} content in milk from northern and eastern Finland was about 2 times higher than in Helsinki and western Finland. In Joensuu and Rovaniemi the peak values with fodder grown in the summer of 1962 were obtained at the beginning of March 1963. Milk samples collected in Aug. to Sept. 1959 from 7 experimental farms in southern and middle Finland contained only 16 pci/l Cs^{137} as an average. The average in Helsinki in Sept. 1962, 110 pci/l, was seven times higher, and the Aug. 1963 average 10 times higher. Data are tabulated. (P.C.H.)

140 CONTRIBUTIONS TO RADIATION PROTECTION WITH SPECIAL REFERENCE TO PULMONOLOGISTS. Karoly Doray and Gyula Koczkas (National Nuclear Physics Inst., Budapest). Tuberkulozis, 14: 99-103(Apr. 1961). (In Hungarian)

After discussing some of the basic principles of radiation protection, the most common hazards involving the use of diagnostic x rays in tuberculosis dispensaries and hospitals are pointed out. It is stressed that the radiologist is the only person involved who needs to be thoroughly protected against radiation either from that emanating from the equipment or scattered from the patient, since he is nearest to the x-ray equipment and is continually being exposed to radiation hazards. Measures for protection of the radiologist are suggested. (BBB)

141 RADIATION HAZARDS IN SPACE. W. E. Kinney. p.15-20 of "Nuclear Safety. Vol. 5, No. 1."

The radiations found in interplanetary space, electromagnetic, primary, cosmic, trapped, and solar, are described, and the hazards associated with each are indicated. The relative importance of the types of radiation described is indicated. Proposed space radiation exposure dose limits are listed. (M.C.G.)

Radiotherapy and Radiodiagnosis

142 THE USE OF IODINE 125 IN THYROID SCINTISCANNING. N. David Charkes and David M. Sklaroff (Albert Einstein Medical Center, Philadelphia). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 1052-8(Nov. 1963).

Thyroid scintiscanning was performed in 97 patients using I^{125}, and in 20 of these patients I^{131} scans were also done, utilizing unmodified conventional photoscanning equipment. In general, I^{125} scans were comparable in quality to those produced by I^{131}. In circumstances in which high resolution was required, as in defining some cold nodules or small pyramidal lobes, I^{125} proved superior. Iodine-125 scans of substernal goiters were inferior to those produced by I^{131}. Iodine-125 thyroid scintigrams may be made simultaneously with I^{131} uptake studies and in conjunction with I^{131} in stimulation and suppression tests of thyroid function. (auth)

143 FECAL EXCRETION OF I^{131}. A PITFALL IN INTERPRETATION OF BODY SCANS. Bernard Schencker and Joseph L. Marcarelli (U. S. Army Hospital, Fort Jackson, S. C.). Am. J. Roentgenol., Radium Therapy Nucl. Med., 90: 1059-62(Nov. 1963).

Whole-body scanning after oral I^{131} is a useful and generally accepted procedure for detection of metastatic thyroid disease. Problems in scan interpretation due to concentration of I^{131} in certain organs are well known. Misdiagnosis based on fecal concentration of I^{131} is reported and discussed. (auth)

144 RADIOISOTOPE SCANNING IN MEDICAL DIAGNOSIS. Joseph P. Kriss (Stanford Univ., Calif.). Ann. Rev. Med., 14: 381-406(1963).

An extensive review is presented and 99 references cited relating to clinical radioisotope scanning for the detection of tumors and mapping of internal organs by determining the spatial distribution of γ-ray- or positron-emitting radioactive nuclides localized in or surrounding the object under study. It is pointed out that successful scanning does not require administration of the high concentration of test materials which are necessary to produce opacity to x rays in certain diagnostic roentgenographic procedures. The important criterion is the relative concentration of the isotope in the organ or tumor with respect to its surroundings, rather than the absolute concentration. Radioisotope scanning has recently achieved greater importance in medical diagnosis largely due to: development of improved radiation detection equipment, development and production of radiopharmaceutical agents that concentrate in particular organs or tissues, and better understanding of the factors necessary to obtain scanning images that are readily interpretable by the clinician. Improvements in scanning equipment are discussed with regard to: the detector and its collimator, apparatus to move the detector, and display of the readings so that the information can be interpreted. Development of instrumentation to meet various requirements for diagnostic tests is discussed, and specific uses of individual radioisotopes in various techniques are outlined as they are applied to organ systems (bone, brain, kidney, liver, heart, pancreas, spleen, thyroid). Detection of tumors in various organs by demonstrating the localization of radioactivity in a given area is also considered, but, it is concluded, the presence of such activity is not specific for tumor tissue, either benign or malignant. In the liver, kidney, spleen, and thyroid any carcinomatous involvement almost always is visualized as a hole in, or displacement of, the normal functioning tissue. At present, no scanning procedure is available which will detect malignant tumors in any part of the body by means of selective isotopic localization in malignant tissue. However, three main lines of investigation are mentioned which indicate such a possibility for the future: tumor uptake of labeled porphyrins, tumor uptake of labeled antihuman antibodies, and incorporation of radioactive halogenated analogs of thymidine into the DNA of neoplastic cells. (BBB)

145 THE USE OF ISOTOPES IN ORTHOPEDICS. I. THE ATOMIC NUCLEUS AND ISOTOPES. Franklin C. McLean (Univ. of Chicago). J. Bone Joint Surg., 45A: 1067-73(July 1963).

The use of radioisotopes in the study of bone, particularly from the viewpoint of the orthopedic surgeon, is discussed. Basic principles of the following topics are considered: atomic and nuclear structure, radioactivity, radioactive decay, and physical half life. Examples are cited of the three types of radiation emitted by isotopes, and their characteristics are outlined. The use of isotopes as tracers, preferably detectable in such minute amounts that their physiological effects are negligible, is based on the assumption that the radioisotope behaves chemically and in the organism in the same manner as the stable forms of the element. Radiocalcium (Ca^{45} and Ca^{47}) in tracer amounts reflects the behavior of the stable Ca^{40}. However, in elements having low atomic wt, a difference in mass between isotopes may introduce a difference in behavior. Thus $D(H^2)$ and $T(H^3)$ do not accurately reflect the behavior of stable H. To a lesser extent, this difference may be true also of the isotopes of C and N. Use of labeled compounds in biochemical research is also discussed. (BBB)

146 THE USE OF RADIOISOTOPES IN ORTHOPEDICS. II. APPLICATION OF RADIOACTIVE TRACER TECHNIQUES TO BONE. Ann M. Budy (Univ. of Chicago). J. Bone Joint Surg., 45A: 1073-83(July 1963).

The following physiological processes, most amenable to study by means of radioisotopes, are discussed: the movement of elements and compounds including their uptake, turnover, exchange, and transfer; and the metabolic pathways and concentration of radioelements, their ionic groupings, and the compounds that may be labeled with radioelements. The methods discussed are autoradiography, radioassay, and external scanning or whole-body counting. Principles and techniques of autoradiography, and results obtained by its use on bone, are briefly recounted. The most striking finding after administration of bone-seeking radioisotopes is their deposition in new and incompletely mineralized osteons. The result is a spotty distribution of discrete foci of intense concentration; these are the areas designated as hot spots. About half of the deposited radiocalcium is diffusely distributed throughout the bone mineral where it produces a uniform darkening of the autoradiograms, at an intensity much lower than that in the hot spots. This diffuse component is responsible for long-term exchange, and remains buried in the mineral for long periods. The methods used for radioassay by counting methods depend on the element involved, the nature of the sample, and the degree of accuracy required. Varieties of counting vessels or holders for various material to be counted are discussed from the viewpoint of the geometry of the system to be used and the self-absorption of the radioactivity by the sample. Characteristics of various counting devices are examined. Scanning of bone at the body surfaces requires emission of penetrating radiation. This may be brought about by three methods: employment

of radioisotopes which themselves emit primary radiation; production of γ radiation as a result of positron annihilation radiation; or bremsstrahlung, comparable to x rays, produced by the influence of β particles entering the electrical field around the nucleus of an atom. The most frequently used procedure for scanning over soft tissues is that of recording γ radiation produced by positron annihilation. Methods for assay and identification of low levels of radioactivity have been greatly improved by the use of large-scale scintillation equipment, the chief advantages of a whole-body counter over equipment which measures localization being its greater sensitivity and accuracy. (BBB)

147 CANCER OF THE BODY OF THE UTERUS FIFTEEN YEARS AFTER CANCER OF THE CERVIX TREATED BY RADIUM THERAPY. P. Langeron and E. Quehen. J. Sci. Med. Lille, 80: 55-62(Feb. 1962). (In French)

A survey of case studies shows that occasionally (in <10% of cases) cancer of the uterine corpus occurs either: simultaneously with cancer of the cervix, a short time after radiation treatment of cervical cancer, or a long time after cervical cancer. The present case was that of a woman aged 74, who had been treated by radium 15 yr previously for cancer of the cervix. What appeared clinically as an abdominal tumor proved upon surgery to be cystic dilation of the uterus with stenosis of the cervical os. The question arose whether there is any causal relation between the two cancers; however, in the present case and from the small percentage of such cases reported in medical literature, it was concluded that no pathogenic relation exists. Six previous studies of this relation are reviewed. (BBB)

148 COMPARISON OF THE DOSE DISTRIBUTION IN DIFFERENT METHODS OF ESOPHAGEAL IRRADIATION. S. Matschke and J. Richter (Robert-Rossle-Klinik der Deutschen Akademie der Wissenschaften, Berlin). Radiobiol. Radiotherap., 4: 385-99(1963). (In German)

Methods of irradiating the esophagus were compared by means of calculated isodoses. The calculation covers 24 Co^{60}-irradiation methods and 4 17-Mv-irradiation methods. Confirmation of the course of the isodoses was obtained by measurements on a body-like phantom. (auth)

149 THE INDIVIDUAL ADAPTATION OF ISODOSES IN THE BIAXIAL PENDULUM IRRADIATION OF GYNECOLOGICAL TUMORS. S. Matschke and K. Welker (Robert-Rossle-Klinik der Deutschen Akademie der Wissenschaften, Berlin). Radiobiol. Radiotherap., 4: 401-9 (1963). (In German)

The possibility of modulating the isodoses when irradiating gynecological tumors in the minor pelvis, according to focal requirements, was examined. The isodose adaptation can be obtained by varying such parameters as field dimension, pendulum axis distance, and pendulum angle. A series of such isodoses are demonstrated. (auth)

150 TANGENTIAL IRRADIATION OF THE BREAST. II. INFLUENCE OF THE CONFIGURATION OF THE BREAST ON THE DISTRIBUTION OF THE DOSE. S. Matschke, K. Welker, and G. Nauber (Robert-Rossle-Klinik der Deutschen Akademie der Wissenschaften, Berlin). Radiobiol. Radiotherap., 4: 411-21(1963). (In German)

The influence of the breast configuration on tangential pendulum irradiation of a preoperative breast carcinoma is discussed. It is pointed out that the bigger the breast, the more difficult it is to get a homogenous load to the thoracic wall and that it is advisable in the presence of a big breast to utilize the composed pendulum irradiation. Useful isodoses are achieved by keeping the fields narrow, but in this case longer periods of irradiation have to be accepted. The calculation of isodoses is very time consuming, as in the 200 kv irradiation the scattering and varying absorption by the ribs are difficult to estimate. Focusing is controlled by x-ray pictures taken with the therapy apparatus at different spots of the course of motion. By measuring the surface doses in every patient and comparing it with isodoses taken on phantoms of different configurations, reliable evidence on the isodoses can be obtained in each case. (auth)

151 THE TREATMENT OF THE RADIOLOGIC REACTIONS OF THE INTESTINE BY THE INTAKE OF PHYSIOLOGIC INTESTINAL FLORA. K. Neumeister and W. Schmidt (Strahleninstitut und der Strahlentherapeutischen Klinik der Medizinischen Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 4: 473-7(1963). (In German)

The influence of intestinal flora on reactions of the intestine to abdominal irradiation is discussed. The frequency of diarrhea following high-level irradiation was reduced by prophylactic use of E. coli, L. acidophilus, and L. bifidus. (C.H.)

CHEMISTRY

General

152 (HW-68716) WATER TREATMENT THEORIES USED AT HANFORD. R. W. Pitman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 2, 1961. Contract AT(45-1)-1350.

The water treatment methods used at the Hanford Atomic Products Operation to produce cooling water for the reactors do not follow the customary methods due to ten minute settling time and low level of suspended materials in the Columbia River water. The purification methods are outlined with respect to necessary filtering materials and water requirements. (N.W.R.)

153 PART I. THEORY OF THREE-BODY FORCES AND THIRD VIRIAL COEFFICIENTS. PART II. NON-EQUILIBRIUM THEORY OF FREE RADICAL REACTIONS. Henry Willingham Graben. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1962. 133p.

In part I it is shown that the form of the 3-body dipole-dipole interaction energy can be deduced from purely electrostatic considerations without the use of classical or wave mechanics. Experimental evidence for this 3-body force is provided by the third virial coefficients of the rare gases. At low temperatures the measured values of the third virial coefficient, C(T), for the noble gases show large deviations (~ 60%) from calculated values. The non-additivity correction, ΔC, to the third virial coefficient is evaluated using the Sutherland model for the 2-body interaction. The Sutherland model provides an automatic cut-off to ΔC whenever 2 atoms begin to overlap. This cut-off for the integrations is needed because the expression for the 3-body force is not accurate at close distances, where higher multipoles contribute and where exchange forces become important. The result is obtained analytically in "corresponding states" form and removes most of the disagreement between the experimental third virial coefficients of the rare gases and the theoretical values. It is concluded that the third virial coefficients of the noble gases provide evidence for the predicted 3-body dispersion forces. In part II the adequacy of the equilibrium hypothesis, upon which the conventional forms of the collision theory and the activated complex theory of chemical reactions are based, is assessed. In particular, the departure of the velocity distribution from the Maxwellian form and the corresponding correction to the reaction-rate formula for the free-radical combination reaction in the presence of an inert gas are calculated. The investigation is approached via the Boltzmann transport equation generalized to include collisions that lead to a chemical reaction. The results indicate that the first-order reaction rate is only 2% greater than that predicted by the equilibrium theory. It is concluded that the equilibrium assumption of chemical kinetics is certainly adequate for the free-radical combination reaction. (M.P.G.)

Analytical Procedures

154 (AAEC/TM-216) OXYGEN QUENCHING ERRORS IN LIQUID SCINTILLATION COUNTING OF $C^{14}O_2$ FOLLOWING SCHONIGER FLASK COMBUSTION. R. W. Matthews (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1963. 12p.

Kalberger and Rutschmann (Helv. Chim. Acta. 44: 1956, 1961) described a method of estimating quantitatively C^{14} compounds on a paper carrier, for example, chromatograms. The sample is combusted in oxygen, the $C^{14}O_2$ produced being absorbed in ethanolamine solution and counted by liquid scintillation techniques. However, errors occur where there are deviations from their experimental conditions, such as in counting equipment or weight combusted, owing to differing concentrations of dissolved oxygen in counting solutions. These errors can be eliminated by scrubbing the ethanolamine absorption solutions with nitrogen before they are mixed with the liquid scintillant. Furthermore, by this additional step, the range of weights combusted can be extended from 130 to 200 mg to 0 to 200 mg. (auth)

155 (AEET/Anal/20) DETERMINATION OF METALLIC THORIUM IN SLURRIES. S. P. Awasthi and K. A. Khasgiwale (India. Atomic Energy Establishment, Trombay). 1963. 9p.

An eudiometric method for determination of metallic thorium was developed using fluoride catalyzed hydrochloric acid for dissolution. The method is useful in a wide range of concentrations of metallic thorium with an accuracy of ±0.7% at 95% confidence level. This method was applied to samples of thorium metal and slurries. (auth)

156 (AEET/ANAL/25) THE SPECTROGRAPHIC ANALYSIS OF URANIUM FOR SIXTEEN TRACE IMPURITIES BY THE CARRIER DISTILLATION METHOD. R. K. Dhumwad, M. N. Dixit, G. Krishnamurthy, B. N. Srinivasan, and B. R. Vengsarkar (India. Atomic Energy Establishment, Trombay). 1963. 22p.

The carrier distillation method for the analysis of nuclear-purity uranium and its compounds has been standardised by using silver chloride and gallium as carrier and internal standard element respectively. Sixteen elements can be analysed simultaneously by giving two different exposures for each pair of the standard and the sample. Only one set of standards incorporating all the sixteen impurity elements has been used. The mean standard deviation of the intensity ratios for the original working curves (based on ten values for each standard of the various elements, from only two plates) varies between 8 and 15. For B, Mn, and Ni, modified working curves were drawn by incorporating the intensity ratios of the various standards exposed in a period of one year, on a number of plates during the course of analysis of samples. The mean standard deviations in the intensity ratios for these elements vary between 13 and 18%. (auth)

157 (AEET/ANAL/27) A QUANTITATIVE SPECTROCHEMICAL METHOD FOR THE ANALYSIS OF ZIRCONIA FOR LOW HAFNIA CONTENT. R. K. Dhumwad and B. R. Vengsarkar (India. Atomic Energy Establishment, Trombay). 1959. Revised 1963. 9p.

A method is described for the determination of hafnia in zirconia in the range of 0.0125 to 0.263%. The charges were excited in an intermittent a-c arc (Hilger F.S. 110) of 6 amp at 230 volts. The Hilger E.492 spectrograph giving a reciprocal dispersion of about 4 Å/mm at 2600 Å was used to photograph the spectra. The line pair chosen was Hf II 2641.406 Å and Zr II 2642.514 Å, the latter being the internal standard line. Standard deviations are 6, 14, and 25% at 0.263, 0.0225, and 0.0125% hafnia respectively. (auth)

158 (AEEW-R-292) THE DETERMINATION OF PLUTONIUM ALPHA ACTIVITY IN URINE, FAECES, AND BIOLOGICAL MATERIALS. M. E. D. Bains (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). July 1963. 34p.

Methods were developed for the determination of plutonium alpha activity in urine, feces, and biological materials. The chemical stages involved give practically complete separation of all extraneous material from the plutonium, which is electrodeposited on to a 0.5-in. stainless steel disc to produce a thin high-resolution source. The limit of detection is 0.025 $\mu\mu c$/sample (sixteen-hour count) when the sources are counted in a small scintillator counter, but is lowest when counted in a counter which counts particles of energy 5.05 to 5.25 Mev only, and which therefore discriminates against small quantities of α-active materials introduced with the reagents in the final electrodeposition stage of the process. (auth)

159 (AERE-AM-94) THE SPECTROGRAPHIC ANALYSIS OF URANIUM AND URANIUM COMPOUNDS BY THE CARRIER DISTILLATION TECHNIQUE. J. C. Cotterill (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Feb. 1963. 28p.

A sample in the form of black uranium oxide is mixed with a carrier, placed in a cupped graphite electrode, and the spectra of the impurity lines excited in a d-c arc at 10 or 12 amp aligned with a spectrograph of large dispersion. Sample spectra are compared visually with standard spectra. Calibration is effected by the inclusion of a standard on the sample plate as density monitor. The method is applicable to refractory oxides for the determination of impurities in the range from 0.1 ppm to 500 ppm. Tables are given showing the sensitive lines and limits of detection for the following elements: Ag, Al, As, B, Ba, Be, Bi, Cd, Co, Cr, Cu, Fe, Ga, Ge, In, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Pd, Rb, Sb, Sn, Sr, Ti, Tl, V, W, Zn. This method is semiquantitative. Duplicates should agree to within ±20% and the mean of duplicates should be within a factor of 0.7 to 1.5 of the true content. (auth)

160 (AERE-AM-97) THE RAPID DETERMINATION OF ZIRCONIUM-95 (Di(2-ETHYL HEXYL) PHOSPHORIC ACID EXTRACTION). J. W. Arden (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Sept. 1963. 14p.

Following the removal of any radioiodine, Zr^{95} is extracted as the di(2-ethyl hexyl) phosphate complex into toluene. This extract, after the removal of any radioiron, is then γ counted. A single determination can be completed in $\frac{1}{2}$ hour. The method is applicable to nitric, hydrochloric, or sulfuric acid solutions of fission products that have cooled for a minimum period of 15 days. The coefficient of variation should not exceed 2% when the counting statistics permit. (auth)

161 (CEA-2318) MESURE DE L'ACTIVITE DE CARBONATE DE BARYUM MARQUE AU CARBONE 14 PAR GELS SCINTILLATEURS. (Measurement of the Activity of ^{14}C-Tagged $BaCO_3$ in Suspension in Scintillating Gels). L. Gilly and R. Bisci (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1963. 13p.

The activity of barium carbonate tagged with C^{14} has been measured with the scintillating gel technique. The scintillator chosen is toluene with 0, 3 per cent of 2,5-diphenyloxazole (P.P.O.), which makes a thixotropic gel with addition of 4 per cent Cab-O-Sil. The gels prepared with this method can take up to 2 g of carbonate in a volume of 20 cm^3. The preparation of the samples is described. The various parameters on which the counting rate depends, were systematically investigated: particle size, temperature, Cab-O-Sil concentration, time, etc. The efficiency was studied with 20 cm^3 and 60 cm^3 bottles. Results were obtained both with the carbotrimetre CTM-1 and with a single-photomultiplier device, and are compared. (auth)

162 (DPSPU-63-30-30) DETERMINATION OF ACTINIDES IN URINE BY LIQUID ION EXCHANGE. F. E. Butler (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Aug. 1963. Contract AT(07-2)-1. 9p. (CONF-212-4)

From 9th Annual Bioassay and Analytical Chemistry Conference, San Diego, Oct. 1963.

A liquid ion exchange method is described for the separation of the α-emitting actinides, Th, Np, U, Pu, Am, and Cm from urine preparatory to radiometric analysis. Anion and cation reactions used to separate the actinides are described. (C.H.)

163 (HW-78734) DETECTION OF AIRBORNE PLUTONIUM USING ALPHA ENERGY ANALYSIS TECHNIQUES. D. P. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1963. Contract AT(45-1)-1350. 14p.

Methods for the detection of low-level plutonium air contamination were examined, and a series of definitive experiments was carried out. A sensitivity of 40 MPC-hr was obtained using alpha-energy analysis techniques where the contributions from higher-energy radon and thoron that appear in the Pu^{239} channel were compensated using electronic balancing circuitry. This provided a considerable reduction in complexity compared to other air particulate monitors of similar sensitivities. Additional experiments showed that gamma background levels of 2 mr/hr and beta particle levels of 2.4×10^4 dpm will not adversely affect the sensitivity or general operation. An increase in air flow rate and/or an increase in detector and filter diameter will improve the basic sensitivity. (auth)

164 (NLCO-884) THE EFFECTS OF VARIOUS GRADES OF GRAPHITE ELECTRODES ON THE CARRIER DISTILLATION OF IMPURITIES IN U_3O_8; SUPPLEMENTAL REPORT. C. E. Pepper and A. J. Pardi (National Lead Co. of Ohio, Cincinnati). Aug. 15, 1963. Contract AT(30-1)-1156. 46p. (CONF-253-4)

From 13th Annual National Lead Company Analytical and Physical Testing Symposium, Hightstown, N. J., Oct. 1963.

Three different grades of graphite electrodes, Ringsdorff RW-0 and RW-I and Ultra Ex-8, were evaluated to determine the graphite effect upon the carrier-distillation excitation of impurities in U_3O_8. Two carrier materials, 6% AgCl-LiF (11 parts of AgCl to 1 part LiF) and 2% Ga_2O_3, were used. National SPK and Ultra U-7 graphites were included to correlate this work with data on seven other graphites previously reported. Quantometric time-resolved spectra were used to determine the spectral sensitivities of 13 impurities. A comparison of the elemental sensitivities in each graphite, relative to each other is presented. The analytical precisions for seven impurities, (Al, Cr, Cu, Fe, Mn, Ni, and Si) were determined in each graphite for each carrier material. The results of a statistical test for significance between the elemental precisions for each graphite are included. The comparative data along with similar data in the earlier work permit one to choose the most beneficial graphite or graphites from among the 10 different grades evaluated; viz., Ultra Carbon Corporation grades

U-1, U-2, U-F4, U-F4S, U-7, and Ex-8; National Carbon Company grades AGKSP and SPK; and Ringsdorff Carbon Corporation grades RW-0 and RW-I. (auth)

165 (NLCO-896) ABSORPTION OF URANIUM ALPHA PARTICLES BY WHATMAN NO. 41 FILTER PAPER. Michael W. Boback (National Lead Co. of Ohio, Cincinnati). Sept. 20, 1963. Contract AT(30-1)-1156. 8p. (CONF-212-2)

From 9th Annual Bioassay and Analytical Chemistry Conference, San Diego, Oct. 1963.

Two-hundred-fifty samples of UF_4, UO_3, and U_3O_8 airborne dusts were collected on Whatman No. 41 filter papers. The quantity of uranium on the filters was calculated from a count of the alpha activity. After counting, the papers were dissolved in acid, and the uranium was determined by a fluorometric method. Comparison of the calculated uranium with the fluorometric uranium showed that the absorption of alpha particles by the filter paper amounted to 50% for papers containing less than 50 μg of uranium. (auth)

166 (NP-13232) UNTERSUCHUNG ÜBER DIE CHELATEXTRAKTION VON Sr-90 AUS WASSER MIT 2-THENOYLTRIFLUORACETON. (Studies on Chelate Extraction of Sr-90 from Water Using 2-Thenoyltrifluoroacetone (thesis)). Klaus-Dieter Beccu (Berlin. Technische Universitat). 1963. 86p.

For the determination of Sr^{90} in waters, the chelate extraction using 2-thenoyltrifluoroacetone followed by activity counting was found to be superior to previously used methods. The high selectivity and detection sensitivity is shown. (M.C.G.)

167 (PAN-392/XIII) DETERMINATION OF RADIOCHEMICAL PURITY OF $Na_2H^{32}PO_4$ AND CARRIER-FREE $H_3{}^{32}PO_4$ BY CHROMATOGRAPHIC METHOD. Krystyna Zelenay and Jerzy Fijałkowski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 12p.

A descending chromatography method for determination of radiochemical purity of $Na_2HP^{32}O_3$ and $H_3P^{32}O_4$ is described. The effects of carriers and time of storage on the composition of the active solution were investigated. (auth)

168 (PAN-393/VIII) A NEW CRITERION FOR THE QUALITATIVE IDENTIFICATION OF SUBSTANCES BY MEANS OF ION EXCHANGE CHROMATOGRAPHY. Rajmund Dybczynski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 7p.

A new criterion for the qualitative identification of substances by means of ion exchange chromatography is proposed. The method involves determination of equilibrium quotient (selectivity coefficient) of the ion exchange reaction by column method at different temperatures. Identification of Tb^{151} by anion exchange chromatography in the system: Amberlite IRA-400 (H_2Y^{2-})–Na_2H_2Y aq. (disodium ethylenediaminetetraacetate) is presented as an illustration of the method. (auth)

169 (PG-Report-448) ANALYTICAL METHOD FOR THE DETERMINATION OF CARBON IN URANIUM OXIDES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 12p.

Uranium oxides, in the form of powder or pellets, are ignited at 900°C in an oxygen stream. Carbon dioxide evolved is isolated by means of a cold trap cooled in liquid oxygen and measured, after expansion at room temperature, as a gas volume. The method is used mainly for uranium dioxide in the form of powder or pellets, but may be applied to any other oxide of uranium. The method is considered to be free from bias. The precision on a thoroughly homogenized sample is: Mean = 240 ppm ± 20 ppm at 95% Confidence Level. The lower limit of detection on a 5 g sample is 10 ppm carbon. (auth)

170 (RT/CHI(63)-21) THE DIRECT SPECTROGRAPHIC DETERMINATION OF BORON, MOLYBDENUM, AND MANGANESE IN URANIUM TETRAFLUORIDE. B. Podobnik (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hannau am Main, Germany); and L. Lorenzini (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia). June 1963. 16p.

A method is described for the determination of some impurities in uranium tetrafluoride. The sample is mixed with 25% of alumina, containing Ge and V as the internal standard elements, and arced in d-c arc of 8 amp, in graphite electrodes. Alumina prevents uranium excitation, transforming volatile uranium tetrafluoride into the refractory uranium oxide during the exposure, and in the same time acts as the spectroscopic carrier. The elements studied are representative of metallic fluorides having different volatilities: boron for very volatile fluorides, molybdenum for medium volatile fluorides, and manganese for the less volatile fluorides. The sensitivities reached are respectively: 0.1 ppm of boron, 0.5 ppm of molybdenum, 0.5 ppm of manganese in UF_4. A procedure is described for the preparation of the standard mixture for the working curves. Some experiments were made to obtain the reproducibility data for these three elements: the standard deviations are below 10% for B and Mo, and below 15% for Mn. (auth)

171 (TID-19618(App.B)) GAMMA SPECTROMETRIC PROCEDURES. Jane McCarthy and R. C. McIhenney (Tennessee. Univ., Knoxville. UT-AEC Agricultural Research Lab.). 39p.

Procedures are described for the quantitative determination of Cs^{137}, Zr^{95}, and Co^{60} in plant materials using a single channel γ spectrometer. (C.H.)

172 THE DETERMINATION OF TRACES OF OSMIUM IN RUTHENIUM SPONGE BY NEUTRON ACTIVATION ANALYSIS. R. Gibels (Universiteit, Ghent). Anal. Chim. Acta, 29: 289-302(Oct. 1963).

Tracer techniques confirmed that a quantitative separation of osmium and ruthenium is possible by distillation from a hydrogen peroxide–sulfuric acid solution. Osmium distils quantitatively as OsO_4 at a temperature of 105 ± 5°C, in about 30 min. The ruthenium contamination is approximately 0.01%. A neutron activation analysis is described for the determination of traces of osmium in ruthenium sponge. When quantities of osmium below 30 ppm are determined, the ruthenium contamination of the distillate must be taken into account, when the measurement is made with a 3 × 3 in. NaI(Tl) crystal. This can easily be achieved by measurement in two energy regions with a γ spectrometer or with a multichannel pulse-height analyzer. With a NaI(Tl) wafer as detector, the correction for ruthenium can be omitted for osmium concentrations above 10 ppm. With the addition method of analysis, 10–2000 ppm in 10-mg samples of ruthenium sponge can be determined by neutron activation analysis. Chemical separation is necessary but no carriers are required. The lowest limit of determination is about 3 ppm for a 3 × 3 in. crystal; for the wafer, about 1 ppm can be determined. (auth)

173 MICROANALYSIS WITH THE AID OF ION EXCHANGERS. PART XXII. DETECTION OF NANOGRAM AMOUNTS OF MOLYBDENUM(VI) WITH TIRON. Masatoshi Fujimoto, Neoyuki Fukabori, and Yukio Nakatsukasa

(Tokyo Univ. and Chiba Univ., Japan). Anal. Chim. Acta, 29: 335-9(Oct. 1963).

A new sensitive and selective resin spot test for nanogram quantities of molybdenum(VI) with tiron is proposed. The limit of identification is 8 ng ($1:5.10^6$) after 1 hour standing. Vanadium(V), chromium(VI), uranium(IV), titanium(IV), palladium(II), platinum(IV), silver(I), and gold(III) interfere. Uranium(VI) (20 ng, $1:2.10^6$) can be detected similarly. (auth)

174 ANALYSIS OF CORROSIVE FLUORINE COMPOUNDS BY GAS CHROMATOGRAPHY. CONTROL OF FREE FLUORINE. O. Rochefort (Centre de Recherches, Lyon). Anal. Chim. Acta, 29: 350-7(Oct. 1963). (In French)

A purely chromatographic and sufficiently general method is described for the analysis of molecular fluorine in permanent inert gases or in other corrosive fluorine compounds (UF_6, HF). The method is also applied to the analysis of permanent inert gases (even in trace quantities) in the same fluorine compounds. In this method, one or several chemical precolumns are placed in series with a gas-liquid chromatography column. The precolumn system retains or destroys the corrosive compounds (UF_6, HF, F_2) and the chromatography column separates the components formed. (auth)

175 THE ANALYSIS OF $^{14}CO-^{14}CO_2$ MIXTURES BY GAS-CHROMATOGRAPHIC SEPARATION AND AQUEOUS SOLUTION COUNTING. H. J. Cluley and J. H. Konrath (General Electric Co. Ltd., Wembley, Middx, Eng.). Analyst, 88: 761-70(Oct. 1963).

A method is described for analyzing $C^{14}O-C^{14}O_2$ mixtures. Gas-chromatographic separation on a silica-gel column was used to determine both the percentage composition and the activity of each constituent. The carbon monoxide emerging from the column was oxidised to carbon dioxide and then frozen out in a cold trap to which sodium hydroxide solution had been added; the carbon dioxide component was isolated in a second cold trap. The activity of the solution from each trap was directly determined by scintillation counting in a cell containing a layer of plastic phosphor cemented to the inside of its base. The rapid separation achieved by gas chromatography permits an analysis to be completed in 40 to 60 minutes, depending on counting time. Results are presented for $C^{14}O-C^{14}O_2$ mixtures covering a range of compositions. (auth)

176 NUCLEAR EMULSION TECHNIQUE IN MEASUREMENT OF RADON. Jan Olof Snihs (Inst. of Radiophysics, Stockholm). Arkiv Fysik, 25: 65-84(1963).

Direct measurement of small concentrations of Rn^{222} is usually carried out by ionization chamber methods or scintillation counting techniques. By concentration methods it is possible to increase the sensitivity. Of the methods which are available for the concentration of the gas itself, probably those using the absorption properties of activated charcoal are the best developed. The experiments described are concerned with the measurement of the α activity of disintegration products collected in an electric field using nuclear emulsion techniques. The methods developed are for application to the measurement of radon in air and breath and of radium in water. A measuring chamber using scintillation technique is also described and a comparison between the two chambers is made. (auth)

177 VANADIMETRIC DETERMINATION OF ZIRCONIUM MANDELATE. K. S. Panwar and J. N. Gaur (Univ. of Rajasthan, Jaipur, India). Indian J. Chem., 1: 361-2(Aug. 1963).

Mandelic acid can be quantitatively oxidized to benzoic acid with vanadium(V). The method was extended to the volumetric estimation of zirconium by first precipitating it as mandelate and then determining the liberated mandelic acid. (auth)

178 A RAPID NEUTRON ACTIVATION METHOD FOR DETERMINING CHROMIUM IN RUBY MASER AND LASER CRYSTALS. Joseph R. Weiner, John J. O'Connor, and Bernard Rubin (Air Force Cambridge Research Labs., Bedford, Mass.). J. Electrochem. Soc., 110: 1160-2(Nov. 1963).

Neutron activation technique coupled with gamma spectrometry was found to be a rapid, accurate, and simple method for the determination of chromium in ruby. Results show good agreement with a chemical-spectrophotometric approach. The advantages of the neutron-activation analysis are that it is rapid, processing of the sample is eliminated, handling is minimized, and the method is nondestructive for certain additional types of testing. Gamma counting of the irradiated sample was found to require only a 1-min duration count. Analysis of rubies with chromium contents in the range of 0.01-5% indicates that there is no correlation with the starting chromium content of powders used in the crystal growth. (P.C.H.)

179 DETERMINATION OF METALS IN HOMEOPATHIC PREPARATIONS BY RADIOACTIVATION ANALYSIS. I. ZINC. J. Pijck (Univ. of Ghent). J. Pharm. Belg., 17: 203-9(July-Aug. 1962). (In French)

Using the same reactor and technique previously described for Cu, a method for Zn assay is described that makes use of the 435-kev γ ray emitted during the disintegration of Zn^{69m} (half life 13.8 hr). Various quantities of Zn in concentrations ranging from 10^{-1} to 10^{-7} could be determined in lactose tablets and biologic samples. Preliminary chemical isolation of Zn as $ZnHg(SCN)_4$ proved necessary for eliminating various contaminants. Results were reproducible and accurate. Purity of the isolated Zn preparations was found, by means of decay measurements and gamma-spectrometry, to be extremely high. (BBB)

180 DETERMINATION OF METALS IN HOMEOPATHIC PREPARATIONS BY RADIOACTIVATION ANALYSIS. II. MANGANESE. J. Pijck (Univ. of Ghent). J. Pharm. Belg., 17: 210-17(July-Aug. 1962). (In French)

Using the previously described techniques for Zn, Mn content of lactose tablets was determined. γ Radiation from disintegrations of Mn^{56}, formed in the reaction $Mn^{55}(n,\gamma)Mn^{56}$, was measured. Various concentrations of Mn, ranging from 10^{-1} to 10^{-7} could be determined. A selective distillation technique, allowing recoveries of 60 to 90%, was used for isolation of Mn. Results obtained were controlled by activation analysis of standard preparation of Mn and compared to spectrophotometric data. Reproducibility and accuracy were satisfactory, the lower limit of the method being at a Mn concentration in lactose of $\sim 10^{-7}$. (BBB)

181 DETERMINATION OF METALS IN HOMEOPATHIC PREPARATIONS BY RADIOACTIVATION ANALYSIS. III. GOLD. J. Pijck (Univ. of Ghent). J. Pharm. Belg., 17: 223-30(July-Aug. 1962). (In French)

By previously described principles, various concentrations of Au, ranging from 10^{-4} to 10^{-10}, were determined by radioactivation. A 5-step decontamination procedure was developed, and the radiochemical purity of the isolated Au fractions obtained was very high. Reproducibility and accuracy were satisfactory, the limit of Au concentration for analysis being $10^{-9}-10^{-10}$. (BBB)

182 BETA BACKSCATTERING APPLIED FOR Au, Ag, Sb, Zn, AND Ca DETERMINATION IN PHARMACEU-

TIC DRUGS. P. Schiller (Commenius-Universität, Bratislava). Kernenergie, 6: 514-16(Sept. 1963). (In German)

Beta backscattering can be used for perfecting quantitative analytical methods. Therefore the dependence of the backscattering intensity on the nuclear charge number and the concentration of the element to be determined in the analyzed material is used. The equipment and methods used are described along with results of investigations of the dependence of backscattering intensity on the Au, Ag, Sb, Zn, and Ca concentrations in some pharmeceutical preparations ans the determination probabilities for these elements are given. (tr-auth)

183 SPECTRAL ANALYSIS OF THE RARE EARTHS. E. W. Salpeter. Met. Ital., 55: 385-90(Aug. 1963). (In Italian)

Emission and x-ray-fluorescence spectra of the rare earths are given. (P.C.H.)

184 SPECTROGRAPHIC DETERMINATION OF METALLIC IMPURITIES IN ORGANIC COOLERS. Z. Hainski and G. Rossi (Euratom, Ispra, Italy). Met. Ital., 55: 391-4(Aug. 1963). (In Italian)

A spectrochemical method for determining metallic impurities in organic coolants is given. The organic bulk is destroyed by dry ashing and the residue dissolved in 5% HCl and analyzed by the copper spark method. By using silver electrodes and palladium as internal standard, straight working curves for Fe, Cu, Ni, Co, V, Tl, Mo, Mg, Cr, and Mn were obtained. The analytical results and the accuracy of the method are briefly discussed. (auth)

185 AMMONIUM DIETHANOLDITHIOCARBOMATE AS NEW REAGENT FOR THE SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM AND URANIUM. W. Haas and T. Schwarz (Universität, Graz). Mikrochim. Ichnoanal. Acta, No. 2, 253-9(1963). (In German)

The ammonium salt of diethanoldithiocarbamic acid was prepared; its behavior toward 36 cations at various p_H levels was studied. Molybdenum and uranium can be determined spectrophotometrically by means of this reagent, either separately or in mixture in concentration ranges from 0.1 to 15 μg Mo^{6+}/ml or 2 to 25 μg U^{6+}/ml with excellent reproducibility. It was found that a number of cations do not interfere with the determination, in some cases after being masked by means of EDTA. (auth)

186 DETERMINATION OF STRONTIUM WITH CERIUM(IV) PERCHLORATE. E. Gagliardi and E. Wolf (Universität, Graz). Mikrochim. Ichnoanal. Acta, No. 3, 578-81(1963). (In German)

A titrimetric determination of strontium with cerium (IV) perchlorate is described. The strontium is precipitated as oxalate; the precipitate is allowed to stand for three to four hours, then filtered, and dissolved in dilute hydrochloric acid. The oxalic acid is titrated with cerium (IV) perchlorate in the presence of nitroferroin as indicator. The procedure is accurate and the error is −1% at most. (auth)

187 GAMMA-RAY SPECTROMETRIC DETERMINATION OF CAESIUM-137 IN SEA-WATER BY USING AMMONIUM MOLYBDOPHOSPHATE AS SCAVENGER. Noboru Yamagata (Inst. of Public Health, Tokyo). Nature, 200: 157-8(Oct. 12, 1963).

A method is described for the determination of very low concentrations of Cs^{137} in sea-water using ammonium molybdophosphate by gamma spectrometry. Only $Zr-Nb^{95}$ interfere with the determination by use of a single-channel analyzer if appreciable amounts of the nuclides are present in sea water. Considering the high efficiencies with which the Cs^{137} in sea water can be carried by the proposed method and the errors involved in activity measurements, neither addition of carrier Cs or spike, nor correction of the results for recovery is necessary. The simplicity of the method makes it convenient for processing samples of large volume. (P.C.H.)

188 APPLICATION OF THE GUTZEIT METHOD TO RADIOCHEMICAL DETERMINATION OF ARSENIC. II. DETERMINATION OF ARSENIC IN SEMICONDUCTOR-GRADE GERMANIUM, SULPHUR AND MINERAL ACIDS. Aleksandra Foldzinska and Jerzy Malinowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 233-6(1963).

Methods are given for the determination of arsenic in semiconductor-grade germanium, sulphur, and mineral acids by neutron activation, using separation by the Gutzeit procedure. The advantages of the method are: high sensitivity, no concentration of acids before analysis needed, simplicity of operations, good reproducibility, and independence from the influence of impurities in the reagents on analysis results. (auth)

189 THE DETERMINATION OF LEAD-210 AND BISMUTH-210 IN BIOLOGICAL MATERIAL. Zbigniew Jaworowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 333-40(1963).

A method for determination of lead-210 naturally present in biological material was described. Pb^{210} was first extracted to the chloroform together with stable lead as lead dithizonate and then Bi^{210}, daughter of Pb^{210}, is separated with cupferron. Beta activity of Bi^{210} is then measured in low-background beta-counting unit. (auth)

190 ANALYTIC FILTERS MADE OF ORGANIC MICROFIBERS AND THEIR USE IN DETERMINING THE CONCENTRATION OF AEROSOLS AND DUST. K. Spurny, M. Polydorova, and Z. Starcuk (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Pracovni Lekar., 14: 369-75(Oct. 1962). (In Czech.)

The filtration properties of Czechoslovak analytic filters are reported. Altogether 15 different kinds were examined, some of which were equal in quality to similar filters of foreign make. The staining properties of filters made of organic fibers, their clogging by industrial aerosols, and their applicability for determining the concentration of radioactive aerosols are considered. Filters made of chlorinated, cold-pressed polyvinylchloride proved best. These filters have a very low resistance to flow, are sufficiently strong, and are able to retain large quantities of samples (tenths of mg). Their efficiency is also satisfactory (>95% with particles of 0.1 μ at 10 cm/sec gas velocity). These filters proved very efficient for retaining radioactive aerosols, because they allow large quantities of air to be sucked through and radioactive particles penetrate the filter only insignificantly. However, they cannot be made as transparent as diaphragm filters and are therefore less suitable for determining the numerical quantity of aerosol concentrations, but they can be easily dissolved in organic solvents. (BBB)

191 p-THIOCRESOL AS A REAGENT FOR TECHNETIUM AND RHENIUM. M. Al-Kayssi and R. J. Magee (Queen's Univ., Belfast). Talanta, 10: 1047-53(Oct. 1963).

p-Thiocresol was developed as a new reagent for technetium and rhenium. By means of it technetium is reduced from the heptavalent state and is determined spectrophotometrically by the color produced between the reduced technetium and the reagent. Rhenium is not reduced, so that a separation of the two elements is facilitated. The influence of other elements was investigated, and a procedure for the

determination of technetium and rhenium is presented. (auth)

192 NON-DESTRUCTIVE ACTIVATION ANALYSIS OF ARSENIC AND ANTIMONY IN LEAD. F. Adams and J. Hoste (Ghent Univ.). Talanta, 10: 1093-1102(Oct. 1963).

A neutron-activation analysis was devised for the non-destructive simultaneous determination of arsenic and antimony in lead. The Sb^{122} and As^{76} activities are computed by gamma counting at two discrete energies. The method was tested with synthetic samples in the antimony and arsenic concentration range of 1 to 10^{-4}%. The reproducibility is generally better than 10%. (auth)

193 MUREXIDE AS AN INDICATOR IN THORIUM-EDTA TITRATION. Satendra P. Sangal and Arun K. Dey (Univ. of Allahabad, India). Talanta, 10: 1115(Oct. 1963).

Murexide (ammonium purpurate) was found to function as an indicator for the complexometric determination of Th. Ammonium purpurate forms a yellow complex with Th that turns pink when an excess drop of EDTA is added to it. Interfering ions are listed. (P.C.H.)

194 THE STABILITY CONSTANT OF THE COMPLEX OF Zr^{IV} WITH EDTA. M. Kyrš and R. Caletka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Řež). Talanta, 10: 1115-16(Oct. 1963).

It is reported that the stability constants (K_{MeY}) and ionic radii (r,Å) of Th, U, Pu, and Zr complexes with EDTA can be correlated by the semiempirical equation: $\log K_{Me(IV)Y} = -16.9 + 38\ 1/r$, ($\mu = 0.1$; Me = Th, U, Pu, Zr) the value for K_{ZrY} being the highest of the four constants. (P.C.H.)

195 SHIELDED FACILITY FOR USE IN THE ANALYSIS OF RADIOISOTOPES. J. E. Morton, H. A. Parker, E. I. Wyatt, and L. T. Corbin (Oak Ridge National Lab., Tenn.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 161-7(1963).

An all-metal shielded facility was constructed at ORNL for use as an aid in the analysis of radioisotopes. Remotely controlled equipment makes possible the preparation of dilutions and the performance of other simple chemical operations inside the cells. Unique features of the facility are the inside-outside analytical balance, the waste-disposal system, and the ease of access to all parts of the cells. Included in the equipment of the cells are a small furnace, filter photometer, pipetter, titrator, and centrifuge. (auth)

Inorganic and Physical Chemistry

196 (ANL-6753) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART II. THE PROPERTIES OF PLUTONIUM HEXAFLUORIDE. Martin J. Steindler (Argonne National Lab., Ill.). Aug. 1963. Contract W-31-109-eng-38. 83p.

All of the properties of plutonium hexafluoride reported up to May 1963 are summarized, and pertinent data are presented in detail. Included are the preparation of plutonium hexafluoride, physical properties, absorption spectra, chemical reactions, decomposition of plutonium hexafluoride by radiation and heat, the corrosion of materials of construction by plutonium hexafluoride, and a summary of the biological and radiological hazards from plutonium hexafluoride. An expanded vapor pressure table is appended. 122 references are included. (auth)

197 (BM-RI-6316) THERMODYNAMIC PROPERTIES OF STRONTIUM CHLORIDE AND STRONTIUM FLUORIDE FROM 0° TO 300°K. D. F. Smith, T. E. Gardner, B. B. Letson, and A. R. Taylor, Jr. (Bureau of Mines. Tuscaloosa Metallurgy Research Center, Ala.). Apr. 1963. 11p.

Low-temperature heat capacities of strontium chloride (7 to 300°K) and strontium fluoride (11 to 300°K) were measured with an adiabatic calorimeter. Smooth values of heat capacity, entropy, enthalpy function, and free-energy function were calculated from the heat-capacity data. The smooth values are reported at 10°K intervals and at 273.15 and 298.15°K. (auth)

198 (GA-4500) THE HIGH-TEMPERATURE CHEMISTRY OF FISSION-PRODUCT ELEMENTS. Summary Report, August 1, 1962–July 31, 1963. U. Merten and W. E. Bell (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 1, 1963. Contract AT(04-3)-164. 29p.

The high-temperature chemistry of oxides of ruthenium, palladium, rhodium, and iridium and chlorides of iridium, osmium, rhodium, and ruthenium is discussed with respect to crystal structure, thermodynamic properties, vaporization, formation, and dissociation. (N.W.R.)

199 (HW-75892) INVENTION REPORT—DEVELOPMENT OF A SOLUTION TO OXIDIZE AND DISSOLVE URANIUM METAL AND ITS OXIDES. R. D. Weed (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 31, 1962. Contract AT(45-1)-1350. 6p.

Decontamination of a high-temperature pressurized-water reactor core-coolant recirculation system following a fuel element cladding failure requires the dissolution of uranium oxides + uranium metal. An oxalic–peroxide–peracetic solution was developed which was found to be superior to other solutions for this task. The solution composition is: oxalic acid, 2.3 g/l; sodium oxalate, 32.0 g/l; hydrogen peroxide, 15.0 g/l; 8-quinolinol, 1.0 g/l; and 40% peracetic acid, 12.5 g/l. 8-Quinolinol suppresses the decomposition of H_2O_2 in steel vessels. Corrosion data indicate that, of all the structural materials tested, only brass and brass alloys are corroded to any extent by this solution. This solution was used in the decontamination of the Plutonium Recycle Test Reactor. (D.L.C.)

200 (IS-618) A STUDY OF THE NITRATE ION DISSOCIATION IN FUSED NITRATES. Roger Nayland Kust and F. R. Duke (Ames Lab., Ames, Iowa). Feb. 1963. Contract W-7405-eng-82. 55p.

A practical electrode system involving an oxygen electrode and a silver-glass electrode was developed for use in an equimolar sodium-potassium nitrate solvent. The overall cell reaction was $2\ Ag^+ + O^{2-} = 2\ Ag + \frac{1}{2}\ O_2$. The reversibility of this system was established, and the standard emf, the temperature dependence of the standard emf, and the ΔG°, ΔH°, and ΔS° values for the cell reaction were determined. The standard emf, the temperature dependence of the standard emf, and the ΔG°, ΔH°, and ΔS° values were also determined for this oxygen electrode in a pure sodium nitrate solvent. The close agreement of the ΔH° and ΔS° values indicated that the standard emf of the electrode system was independent of the Na^+ to K^+ ratio of the solvent. This electrode system made possible the direct measurement of oxide ion concentration. The equilibrium constant for the reaction $S_2O_7^{2-} + NO_3^- = 2\ SO_4^{2-} + NO_2^+$ was re-evaluated, and more accurate values for several temperatures were obtained than those previously published. Also the ΔG°, ΔH°, and ΔS° values for this reaction were determined. With the aid of these equilibrium constants the dissociation constant of the nitrate ion in nitrate solvents was determined at two temperatures. The ΔH° for

the nitrate ion dissociation was calculated. The dissociation constant for the decomposition of the carbonate ion in an equimolar sodium-potassium nitrate solvent was determined. The value obtained was much larger than would be expected from known thermodynamic information. The reaction of an oxide ion with a nitrate ion to give an orthonitrate ion $NO_3^- + O^{2-} = NO_4^{-3}$ was proposed to explain the apparent lowering of the oxide ion activity. In support of this proposition, it was shown that the addition of nitrate ion to anhydrous lithium perchlorate containing a known quantity of lithium oxide lowered the activity of the oxide ion a small amount. (auth)

201 (JEN-116-DMe/I-11) ESTUDIOS ENCAMINADOS A LA CARBURACTION DEL CIRON COMO ETAPA INTERMEDIA EN LA OBTENCION DE CIRCONIO. (Zircon Carburation Studies as Intermediate Stage in the Zirconium Fabrication). V. Almagro Huertas, L. Saez de Tejada Gonzalez, and M. Lopez Rodriguez (Spain. Junta de Energia Nuclear, Madrid). 1963. 26p.

Zirconium carbide and carbonitride mixtures were obtained by Kroll's method. Reaction products were identified by micrography and x-ray diffraction analysis. The optimum graphite content in the initial charge for the carburization reaction was studied. Zirconium, silicon, and carbon content in the final product was controlled as a function of current in the furnace and reaction time. Further chlorination of the final product was performed successfully. (auth)

202 (LADC-5867) THE RECOMBINATION OF OXYGEN ATOMS AT HIGH TEMPERATURES AS MEASURED BY SHOCK TUBE DENSITOMETRY. John H. Kiefer and Robert W. Lutz (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract [W-7405-eng-36]. 19p. (CONF-270-1)

From Western States Combustion Symposium, Los Angeles, Oct. 1963.

The rate of recombination of oxygen atoms was measured by shock tube x-ray densitometry in the range 1500 to 2700°K. Mixtures of ozone, oxygen, and argon were driven with helium in a three-inch shock tube and density records obtained for each experiment. Within two microseconds after the arrival of the shock wave, the rapid reactions $O_3 + M \xrightarrow{k_1} O_2 + O + M$ and $O_3 + O \xrightarrow{k_2} 2O_2$ have removed all but a negligible amount of the original ozone and produced excess oxygen atoms. The oxygen atom concentration at every subsequent time is then determined by the density of the gas, and the recombination rate is obtained from the gradual decrease in density behind the shock front. The reaction $O + O + O_2 \xrightarrow{k_4} 2O_2$ is the dominant recombination reaction in this system, and its rate is found to be $k_4 = 2.7 \pm 0.5 \times 10^7 \exp(7000 \pm 1000/T)$ (liter^2/mole^2-sec). (auth)

203 (LADC-5930) HIGH-TEMPERATURE HEAT CONTENT OF URANIUM CARBIDES. L. S. Levinson (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 12p. (CONF-206-2)

From Symposium on Carbides in Nuclear Energy, Harwell, Eng., Nov. 1963.

A drop calorimeter, with a graphite tube furnace and an adiabatically shielded receiver block, was used to measure the heat contents of uranium carbides. The heat contents were referred to 310°K. An IBM 7090 computer was used to fit the data to a power series of the following type: $H_T - H_{310°K} = A + BT + CT^2$. Enthalpy values of 0.409 cal/g for tetragonal $UC_{1.93}$, 0.844 cal/g for cubic $UC_{1.93}$, and 0.429 cal/g for $UC_{0.99}$ were determined. (M.C.G.)

204 (NAA-SR-8388) REPROCESSING OF URANIUM CARBIDE BY A NITRIDE–CARBIDE CYCLE. I. KINETICS OF NITRIDE FORMATION. L. A. Hanson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 31, 1963. Contract AT-11-1-GEN-8. 37p.

The reaction of uranium carbide with nitrogen was investigated in relation to the effects of: UC age (time of UC exposure to air saturated with water vapor at room temperature) in the range from 0 to 120 days; initial UC particle size from 4 mesh to less than 400 mesh; UC composition from 3.59 to 5.55 wt % carbon; nitrogen pressure from 10 to 600 mm Hg absolute; and reaction temperature from 550 to 1050°C. The reaction changes the UC to a powder consisting of a mixture of carbon and uranium nitrides; the principal nitride phase was identified as U_2N_3. The reaction rate of aged UC is higher by a factor of 28 over freshly melted UC. The reaction rate varies with UC particle size, having a maximum rate for –400 mesh powder and a minimum for the 100 to 200 mesh size fraction. The reaction rate varies with uranium carbide composition and is a minimum for slightly hypostoichiometric UC. The reaction rate varies as the $^3/_4$ power of the nitrogen pressure. The reaction rate is postulated as being controlled by the formation of the U_2N_3 phase below 650°C; whereas, above 650°C, the observed reaction rate is a combination of a primary process, U_2N_3 formation, and a secondary inhibiting effect probably caused by the decomposition of the U_2N_3 phase. Activation energies of 31.8 ± 1.3 kcal/mole for the primary reaction and 37.4 ± 2.2 kcal/mole for the secondary reaction were determined. Oxidation of the nitride in air at room temperature was noted. (auth)

205 (NRL-6004) HIGH-TEMPERATURE PROPERTIES OF SODIUM AND POTASSIUM. Eleventh Progress Report, April 1 to June 30, 1963. C. T. Ewing, J. P. Stone, J. R. Spann, E. W. Steinkuller, and R. R. Miller (Naval Research Lab., Washington, D. C.). Sept. 13, 1963. 4p.

Preliminary results are presented for the saturated vapor pressure of potassium from 0.34 to 27.3 atm and the specific heat of the saturated liquid from 1300 to 2100°F. Pressure-volume-temperature data for the vapor states of potassium at 1573 to 2520°F and 2.3 to 24.3 atm are obtained, and a thermodynamic treatment of the data is underway. (auth)

206 (NYO-10695) PROPERTIES OF ELECTROLYTES IN SOLVENT MIXTURES. Final Summary Report. Robert L. Kay (Brown Univ., Providence). Sept. 30, 1963. Contract AT(30-1)-2727. 40p.

An investigation was made to test theories of properties of electrolytes in solvent mixtures, particularly the Fuoss-Onsager conductance theory. Conductance measurements were carried out on KCl and CsCl in ethanol–water mixtures, LiCl and CsCl in anhydrous methanol, and KCl in acetone–water mixtures. An improved guard electrode cell was developed for the measurements. It was found that the concentration dependence of transference numbers could be used to obtain the electrophoretic contribution to conductance. Transference numbers were measured for LiCl in anhydrous methanol. Guarded dielectric cells for measurement of absolute dielectric constants were used to measure the dielectric constant of H_2O and D_2O at 0 to 40°C, of benzene with very low concentrations of ethylenimine, and of ethylenimine. (D.L.C.)

207 (ORNL-3497) APPARATUS FOR THE GASOMETRIC STUDY OF SOLID-GAS REACTIONS: SODIUM

FLUORIDE WITH HYDROGEN FLUORIDE AND URANIUM HEXAFLUORIDE. Sidney Katz (Oak Ridge National Lab., Tenn.). Oct. 29, 1963. Contract W-7405-eng-26. 17p.

A gasometric apparatus for rapidly characterizing dissociation pressures, sorption equilibrium and kinetics, chemical states, and decomposition conditions was built and tested. The method involves the measurement of quantities of gases reacting with or evolving from known quantities of solid. Accuracies of better than ±1% were attained. In testing the capabilities of the apparatus, the dissociation pressures of hydrogen fluoride and uranium hexafluoride over their respective complexes with sodium fluoride, and the decomposition of the uranium hexafluoride complex to give elemental fluorine were verified. Additionally, a test for sorption of uranium hexafluoride on sodium fluoride was developed, the existence of the compound Na_2UF_8 was demonstrated, a more active form of sodium fluoride was made, the stability of the pentavalent uranium–sodium fluoride complex was studied, data leading to a postulated new compound $(NaF)_2(UF_6)(HF)$ was obtained, and the interaction of hydrogen fluoride and uranium hexafluoride on sodium fluoride was studied. (auth)

208 (PAN-394/VIII) THE THERMODYNAMICS OF ANION EXCHANGE OF THE RARE EARTH ETHYLENEDIAMINETETRAACETATES. Rajmund Dybczynski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 32p.

Distribution coefficients for the ion exchange reaction of the rare earth ethylenediaminetetraacetates in the system strongly basic anion exchange resin Amberlite IRA-400–aq. solution of di-Na-ethylenediaminetetraacetate were determined by column method with the use of radioactive tracers. From these data, partial molal free energy (ΔG^*), enthalpy (ΔH^*), entropy (ΔS^*), and heat capacity (ΔCp^*) changes were computed. The ΔH^* values are of the same order as in the case of exchange reactions in which simple inorganic ions take part. Relatively high however, are ΔS^* values which prove that entropy changes can be of considerable influence on selectivity coefficient values in the case of exchange reactions in which complex ions take part. Unexpectedly high are also ΔCp^* values. It was shown that selectivity coefficient for the exchange reaction of monovalent ions can in contrary to general opinion both decrease and increase with the raise of temperature. The significance of the influence of temperature on the course of rare earth separation by column chromatography on anion exchange resins was pointed out. (auth)

209 (TID-19632) THE PREPARATION AND SOME PROPERTIES OF A EUROPIUM DICARBIDE PHASE. Robert E. Gebelt and Harry A. Eick (Michigan State Univ., East Lansing). [1963]. Contract AT(11-1)-716. 16p.

A lanthanon dicarbide, EuC_2, was prepared in a stainless steel bomb by the reaction of the metal with graphite. The lattice parameters, some chemical properties, and a comparison of this phase with other dicarbide phases are presented. (auth)

210 (TID-19634) HIGH MOLECULAR WEIGHT BORON SULFIDES. II. IDENTIFICATION AND RELATIVE INTENSITIES. Frank T. Greene and Paul W. Gilles (Kansas. Univ., Lawrence). [1961]. Contract AT(11-1)-1140. 15p.

New boron sulfides with molecular weights extending to above 850°C were investigated by mass spectrometric techniques. Slightly sulfur-rich B_2S_3 samples of natural boron and enriched B^{10} were prepared, analyzed, and, in a mass spectrometer, vaporized at temperatures between 300 and 600°C. The ions appeared in three series and were identified by mass number, isotopic intensity distribution, and isotope shift. Series I consists of 37 ions containing boron and sulfur alone; Series II, 18 ions containing also a third element, tentatively identified as sulfur; Series III, 11 ions containing a different third element, probably oxygen. Time, temperature, and electron energy dependences indicate the presence in each series of several neutral molecules vaporizing from the sample. The relationship of the new substances to the hydrocarbons and the boron hydrides is suggested, and possible structural arrangements are discussed. (auth)

211 (TRG-Report-438) THERMAL CONDUCTIVITY AND VISCOSITY OF CO_2. THE CORRELATION OF EXPERIMENTAL DATA TO COVER THE RANGES 0–1100°C AND 15–1000 lb/in^2(abs). K. Sullivan (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England). 1963. 42p.

Data giving significantly different values for thermal conductivity and viscosity of CO_2 are in use in the nuclear power industry, and the need has arisen for a set of data embodying the latest experimental determinations. New correlations were derived from an exhaustive search of the literature for original experimental values. Each of the works from which values are extracted was critically reviewed, and notes are included on the various methods used by the experimentors. Consideration is given to the application of weighting factors to the data used in the correlations, but the conclusion reached is that no reliable method is available for evaluating the factors. The selected data were programmed for the IBM 7090 computer, and curves were fitted by the method of "least squares." In presenting results, recognition is given to the need for data to be in a form suitable for computer use, and mathematical expressions for the fitted curves are given. The atmospheric pressure data are expressed in terms of temperature, and, for the high pressure data, use was made of the relationship between the residual properties and density. Reference is made to tabulated values computed from the expressions. (auth)

212 (UCRL-10841) OLD AND NEW PROBLEMS IN THE FIELD OF VAPOR-LIQUID EQUILIBRIA. Otto Redlich (California. Univ., Berkeley. Lawrence Radiation Lab.). July 16, 1963. Contract W-7405-eng-48. 6p. (CONF-271-1)

From 13th Canadian Chemical Engineering Conference, Montreal, Oct. 1963.

A review is presented on vapor-liquid equilibria. Among the topics discussed are activity coefficients, consistency criteria, automatic computation, and gaseous mixtures. A bibliography of 18 references is included. (D.L.C.)

213 (UCRL-10848) CHEMICAL REACTIONS IN CROSSED MOLECULAR BEAMS (thesis). James Arnold Norris (California. Univ., Berkeley. Lawrence Radiation Lab.). June 27, 1963. Contract W-7405-eng-48. 90p.

Crossed molecular beam studies are made of the reactions K + RI → R + KI, where R is CH_3, C_2H_5, etc. The experimental techniques and theoretical treatment necessary for this study are discussed. From comparisons of the angular distributions of KI observed experimentally with computer-calculated distributions it was possible to gain information about the angular distributions of products in the center-of-mass system and about the internal excitation of the products. The results show that 75 to 100% of the energy released in the reaction appears as internal excitation of the products and that the angular distribution is quite anisotropic, with most of the KI recoiling backward (and R forward) with respect to the incoming K

beam. This anisotropic distribution indicates that a long-lived reaction complex is not formed and that any complex that is formed decomposes within a time not much longer than 10^{-12} seconds. (auth)

214 (NP-tr-1064) AUTOMATIC APPARATUS FOR THE GRAVIMETRIC MEASUREMENT OF GAS SORPTION, PARTICULARLY FOR THE DETERMINATION OF SPECIFIC SURFACE AREA AND PORE SIZE. G. Sandstede and R. Robens. Translated by Kathlyn Fforde (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Dechema Monograph., 44: 59-81(1962). 42p.

An apparatus was developed for the automatic plotting of ad- and desorption isotherms. The apparatus comprises an automatically operated evacuating and gas-conducting plant with manostat and thermostat devices, combined with an electronic microbalance. In its operation, the ad- and desorbed gas is measured by weighing the sorbent, and the results are continuously recorded. (D.L.C.)

215 (UCRL-Trans-962(L)) DETERMINATION OF DIFFUSION COEFFICIENTS TAKING INTO ACCOUNT A PHASE BOUNDARY REACTION. R. Haul, G. D. Duembgen, and D. Just. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Z. Physik. Chem. (Frankfurt), 31: 309-20(1962). 24p. (Includes original, 7p.).

With heterogeneous isotope exchange experiments to determine diffusion coefficients in solids a retardation may occur at the passage through the phase boundary surface. For the case of diffusion from a finite, at all times homogeneous, phase into a solid a solution and a description of the evaluation procedure are given. In this way both diffusion coefficients and rate constants of the phase boundary reaction may be ascertained. (auth)

216 ELECTRON MICROSCOPE STUDY OF GRAPHITE BROMIDE. M. Heerschap and P. Delavignette (S.C.K.-C.E.N., Mol, Belg.). Appl. Phys. Letters, 2: 224-5(June 1, 1963). (EUR 390.e)

Natural and purified single crystals of graphite were exposed to bromine vapor for some minutes and left standing for some days in order to have the peculiarities caused by the intercalated bromine molecules observable. The crystals revealed isolated partial dislocations in an electron microscope. The results suggest that dislocations bound the intercalated bromine layers and that the hexagon networks on either side of a bromine layer are in a over a stacking. (P.C.H.)

217 HEAT OF IMMERSION OF URANIUM DIOXIDE IN WATER. D. Kolar (Nuclear Institute "Josef Stefan," Ljubljana, Yugoslavia). Croat. Chem. Acta, 35: 123-7 (1963).

Heats of immersion of UO_2 powders in water were determined by calorimetric measurements. The integral heat of immersion at 25°C was found to be 490 erg/cm^2 with an uncertainty ±7% for stoichiometric UO_2. The value is linearly increasing with increasing non-stoichiometry of the powders up to 790 erg/cm^2 ± 7% for U_3O_8. The result is not influenced by different particle size distribution, obtained by different methods of synthesis of UO_2 powders. (auth)

218 STUDY OF FAST ISOTOPIC EXCHANGE REACTIONS USING THE FLOW TECHNIQUE. R. Mahadeva Iyer and P. S. Menon (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 1: 327-9(Aug. 1963).

A dynamic flow technique is described for the study of fast isotopic exchange reactions involving exchange half times of less than 10 sec. The feasibility of the technique was proved by a study on the $Fe^{2+}-Fe^{3+}$ electron transfer system in perchlorate medium. (auth)

219 ISOTOPE AND ION EXCHANGE BETWEEN URANATE PRECIPITATES AND THE IONS OF ALKALI ELEMENTS. N. I. Pechurova, L. M. Kovba, and E. A. Ippolitova. Issled. v Obl. Khim. Urana, Sb. Statei, 108-20 (1961).

The isotope and ion exchange between uranates precipitated from the solution at 22–85.6°C and the ions of alkali metals reached equilibrium within 30 min. The isotope exchange between uranates of Na, K, Rb, and Cs with the equivalent quantity of the corresponding chlorides from the solutions is 21.68–83.38 and 28%, respectively. The degree of isotope exchange increases with increasing temperature. The ion exchange of lithium uranate with Na^+, Rb^+, and Cs^+ drops in this order from 8 to 2% which, it is thought, is associated with the increasing difference of the ion radii. The ion exchange of sodium uranate with K^+, Rb^+, and Cs^+ is 30, 20, and 30%, respectively; that of potassium uranate with Na^+ and Cs^+ is 40 and 30; and that of cesium uranate with Na^+ and Rb^+ is 20 and 64%, respectively. (Referativnyy Zhurnal Khimiya, No. 18, 1962)

220 DISSOCIATION OF POLYATOMIC IONS IN COLLISIONS WITH ATOMIC AND MOLECULAR GASES. S. E. Kupriyanov and A. A. Perov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1102-9(Aug. 1963). (In Russian)

Dissociation of ions of water, ammonia, methane, ethylene, and propane was studied, and the effective cross sections were determined for collisions with atomic neon and molecular deuterium and air. Mass-spectrometric methods were used. The dissociation cross section of CH_4^+ ions from methane by all processes except $CH_4^+ \rightarrow CH_3^+ + H$ increased with increasing ion energy to the maximum, which was in the region of 30 to 80 kev. The sharper maximums corresponded to processes requiring less energy. In the high-energy regions, around 80 kev, the cross section of the CH_4^+ ion dissociation was independent of the number of hydrogen atoms removed. In the low-energy regions, around 3.5 kev, the dissociation spectra resulting from collisions with heavy particles were remarkably similar to the mass spectra of the corresponding spectra from ionization by electrons with energies in the range 50 to 100 ev for water, ammonia, methyl, methane, ethylene, and propane. The change in energy of electrons at 10 ev near the potentials of the appearance of ions resulted in a significant change in the value of the dissociation cross section. This is explained by an increase in the number and degree of excitation of similar ions by high-energy electrons. Data at 3.5 kev showed that dissociation is greater the more hydrogen atoms the ion contains. (TTT)

221 STERIC ORIGIN OF SOME SECONDARY ISOTOPE EFFECTS OF DEUTERIUM. Vernon F. Raaen, Theodore K. Dunham, Dorothy D. Thompson, and Clair J. Collins (Oak Ridge National Lab., Tenn.). J. Am. Chem. Soc., 85: 3497-9(Nov. 5, 1963).

The differential method for determining isotope effects was now extended to the acid-catalyzed reactions with 2,4-dinitrophenylhydrazine at 0° of several other carbon-14 labeled ketones. All carbonyl-labeled ketones investigated exhibited isotope effects (k^*/k) very close to 0.95. For the reaction of acetophenone-1-phenyl-C^{14}, $k^*/k = 1.0038 \pm 0.0003$. By using carbon-14 as a tracer for either hydrogen or deuterium, the differential method was also employed for determining isotope effects due to deuterium. The results for deuterium are discussed in terms of a previously proposed mechanism for carbonyl reactions and are explained on steric grounds. (auth)

222 RAPID LIGAND EXCHANGE IN ZIRCONIUM(IV) CHELATES. A. C. Adams and E. M. Larsen (Univ. of

Wisconsin, Madison). J. Am. Chem. Soc., 85: 3508-9 (Nov. 5, 1963).

The hypothesis that rapid ligand exchange occurs in zirconium(IV) chelates was verified by the nmr spectra of mixtures of tetrakis-(2,4-pentanediono)-Zr(IV), $Zr(acac)_4$, and tetrakis-(1,1,1-trifluoro-2,4-pentanediono)-Zr(IV), $Zr(tfac)_4$. Because of rapid exchange of the ligands, a solution of $Zr(acac)_4$ and $Zr(tfac)_4$ contains five compounds: $Zr(acac)_4$, $Zr(acac)_3(tfac)$, $Zr(acac)_2(tfac)_2$, $Zr(acac)(tfac)_3$, and $Zr(tfac)_4$. (P.C.H.)

223 THE HYDROGEN–GRAPHITE REACTION BETWEEN 360 AND 800°. P. Breisacher and P. C. Marx (Aerospace Corp., El Segundo, Calif.). J. Am. Chem. Soc., 85: 3518-19(Nov. 5, 1963).

Studies were made on the hydrogenolysis of graphite at 360 to 800°C. Below 580°C the reaction was zero order with respect to hydrogen at pressures of 90 to 180 cm. The reaction order gradually increased above 580°C and reached 0.6 at 800°C. The rate constant for methane production varied from 2.0×10^{-16} (360°C) to 3.3×10^{-12} mole per g sec (800°C). An increasing proportion of 5 higher hydrocarbons in the reaction products below 650°C was found. The mechanism of the reaction is discussed. (P.C.H.)

224 CALCULATION OF HEATS OF VAPORIZATION AND FUSION ON NONIONIC LIQUIDS FROM THE RIGID-SPHERE EQUATION OF STATE. S. J. Yosim and B. B. Owens (Atomics International, Canoga Park, Calif.). J. Chem. Phys., 39: 2222-6(Nov. 1, 1963).

The heats of vaporization of the rare gases, diatomic, and polyatomic molecules were calculated from the isothermal reversible work required to compress a fluid of rigid spheres from the volume it occupies at a pressure of one atmosphere to the volume of the corresponding liquid. Similarly the heats of fusion of the rare gases were calculated from the additional work necessary to compress the rigid-sphere fluid from the volume of the liquid to that of the solid. Agreement between the calculated and observed values was, with few exceptions, very good. (auth)

225 CRITERION FOR ORDERING THE BOND STRENGTHS OF NEUTRAL AND POSITIVELY CHARGED HYDRIDES. R. E. Stanton (Canisius Coll., Buffalo and Union Carbide Research Inst., Tarrytown, N. Y.). J. Chem. Phys., 39: 2368-73(Nov. 1, 1963).

A simple criterion was developed for ordering the bond strengths of isoelectronic hydrides, particularly positive ions with the formula $M_{z+1}H_n^+$ and the corresponding neutral molecules M_zH_n. For monohydrides the criterion states that the bond strength of the ion will be greater than that of the neutral molecule whenever the ionization potential of the atom M_{z+1} is less than 13.6 ev. When this ionization potential is significantly greater than 13.6 ev the neutral molecule has the stronger bond. For polyhydrides the total dissociation energy of the ion is almost always greater than that of the neutral molecule. Extensive experimental evidence in support of this criterion is presented. (auth)

226 VOLTAMMETRY OF IRON IN MOLTEN LITHIUM FLUORIDE–POTASSIUM FLUORIDE–SODIUM FLUORIDE. D. L. Manning (Oak Ridge National Lab., Tenn.). J. Electroanal. Chem., 6: 227-33(Sept. 1963).

The voltammetry of iron(II) in molten LiF–NaF–KF was investigated over the temperature range 470-545°C. The current-voltage curves were recorded using a controlled-potential polarograph and a stationary platinum micro-electrode coupled with a platinum quasi-reference electrode. A third platinum electrode, which was isolated, served as the counter electrode. The reduction of iron(II) to the metal and the oxidation of iron(II) to iron(III) appeared to proceed reversibly under the existing experimental conditions. The limiting current (wave height) of the cathodic wave was proportional to the concentration of iron in the melt. An activation energy of about 12 kcal/mole was calculated for the current limiting process, which corresponded to the reduction of iron(II) to the metal. (auth)

227 EXCHANGE REACTION BETWEEN DEUTERIUM AND WATER ON NICKEL IN ALKALINE SOLUTIONS: COOPERATION OF RIDEAL-ELEY MECHANISM AND MECHANISM OF HYDROGEN ELECTRODE REACTION. Michio Enyo, Masamitsu Hoshi, and Hideaki Kita (Hokkaido Univ., Japan). J. Res. Inst. Catalysis, Hokkaido Univ., 11: 34-54(July 1963).

Exchange reactions between pure deuterium and aqueous alkaline solutions were carried out on nickel wire catalyst at various pH's and deuterium pressure at 0 ~ 50°C. The exchange rate and the heat of activation were independent of pH (7 ~ 13), being approximately 10^{-5} A/cm^2 at 1 atm in exchange current density and 9 kcal/mole, respectively. The degree of equilibration, $\rho = P_{PD}/P_{PD,eq}$, where P_{PD} is partial pressure of protium deuteride in the sample gas directly after the exchange and $P_{PD,eq}$ that when the same gas is brought to equilibrium with respect to $P_2 + D_2 = 2PD$ subsequently, was found at 0.7 ~ 0.9 practically independent of pH, hydrogen pressure or temperature. From the results, it was concluded that from negligible pH-effect upon the exchange rate or upon the heat of activation, the catalytic mechanism is valid on nickel hydrogen electrode in alkaline solutions at least at its equilibrium potential, and that from $\rho > 0$, Rideal-Eley mechanism, $H_2 + H(a) \rightarrow H(a) + H_2$, is taking place concurrently and in parallel with the rate-determining recombination step, $2H(a) \rightarrow H_2$, of the catalytic mechanism, where H(a) is the adsorbed hydrogen atom. Individual rates of the Rideal-Eley and the catalytic mechanisms, both of which contribute to the exchange reaction, were determined by analyzing experimental results on D, the deuterium atomic fraction, and ρ. Importances of concurrent operation of the Rideal-Eley mechanism in studies of reaction kinetics are briefly discussed. (auth)

228 SPHERULITIC GROWTH OF STRONTIUM SULFATE IN THE PRESENCE OF EDTA. Sadaichi Otani and Masaji Miura (Hiroshima Univ.). J. Sci. Hiroshima Univ. Ser. A-II, 27: 11-15(June 1963).

Crystallization of strontium sulfate from supersaturated solution was retarded in the presence of small amounts of EDTA, and the habit of the resultant crystals was modified to two-dimensional spherulite. Electron micrographs and diffraction patterns of the spherulite show that it is composed of many slender crystallites, each of which is elongated along the a-axis and directed radially. The (010) face of each crystallite is perpendicular to the spherulite plane, to which, accordingly, the (001) faces of all crystallites must be parallel. The mechanism of the formation of such a spherulite is discussed in terms of the adsorption of EDTA on the growing crystallites. (auth)

229 STRUCTURAL PROPERTIES OF URANIUM COMPOUNDS. I. SPACE STRUCTURE OF URANYL COMPOUNDS. Jozsef Szoke. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 289-309(1963). (In Hungarian)

To elucidate the problem of normal chelates, systematical thermoanalytical investigations were carried out on available uranyl chelates. The complex composition associated with the thermostable state was found to be a characteristic feature of the ligand and not of the metal ion,

and thermostable states were found to exist only for complexes in which the ligand is distilled or sublimed out at the rupture temperature of the metal-ligand bond. Actually a disproportionation is taking place in the case of the dissolution of any complex in a thermostable state. The experiments to synthetize mixed chelate complexes from thermostable products were unsuccessful since a mixture of complex compounds of corresponding stoichiometric ratio was produced from the various ligands. The conditions for the formation of non-chelate and chelate-dipole mixed complexes were investigated with respect to synergism occurring for extraction processes. An attempt is made at the interpretation of the results of Cunningham, Blake, and Irving from the proposed space structure. It is shown that, even more than the conditions mentioned by Irving, the screening effect of the ligands on uranyl oxygens as well as the interaction between the ligands and the non-polar solvent play an important part. (auth)

230 FAR ULTRA-VIOLET ABSORPTION SPECTRA OF CERIUM(III) AND EUROPIUM(III) AQUA IONS. Chr. Klixbuell Joergensen (Cyanamid European Research Inst., Cologne) and Jacob S. Brinen. Mol. Phys., 6: 629-31(July 1963).

The far ultraviolet absorption spectra of Ce and Eu is reported and discussed. The relatively broad and weak electron transfer bands were found to have the lowest wave-number in the most oxidizing central ion, Eu(III). A solution of 0.03 M Eu(III) perchlorate in 0.1 M $HClO_4$. shows a maximum at 188 mμ, with the molar extinction coefficient $\epsilon = 235$ and the half-width towards smaller wave-numbers $\delta(-) = 5.1$ kK. Other lanthanide solutions, such as Ce(III), Pr(III), and Tb(III) perchlorates, exhibit relatively narrower bands caused by $4f \rightarrow 5d$ transitions. A sixth band of Ce(III) was found at 200 mμ with $\epsilon = 170$ and $\delta(+) = 1.4$ kK. (P.C.H.)

231 EXPERIMENTAL EVIDENCE FOR THE TRIPLET CHARACTER OF THE LOWEST EXCITED STATE OF THE URANYL ION. Michelle M. Fayt, Elisabeth M. Vandeput, and Stephan A. de Jaegere (Université, Louvain, Belg.). Nature, 200: 355-6(Oct. 26, 1963).

Evidence that the lowest excited state of uranyl ion is a triplet state is presented. When uranyl in aqueous solution is complexed with various species (nitrate ion, hydrogen sulfate ion, molecular oxygen) the vibrational fine structure of its absorption spectrum in the portion 3500–5000 A always undergoes the same change, as compared with this structure for uncomplexed uranyl. The observed is a variation in the intensity distribution of the fine structure maxima. Besides a change in intensity distribution, an overall increase in absorption occurs by complexing uranyl. (P.C.H.)

232 PHYSICAL PROPERTIES OF MOLTEN REACTOR FUELS AND COOLANTS. W. D. Powers, S. I. Cohen, and N. D. Greene (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 200-11(Oct. 1963).

A summary is presented of the available physical property data on 94 molten fluoride salt mixtures that were evaluated for utilization as high temperature fluid fuels and reactor coolants. The specific physical properties, which were either measured or calculated, include density, heat capacity, heat of fusion, enthalpy, viscosity, thermal conductivity, and electrical conductivity. The experimental techniques and apparatus used in making the measurements are described, and the probable experimental errors are given. Some of the problems and potentialities of reactor systems using molten salt fuels and coolants are also briefly discussed. (auth)

233 ON THE HEAT OF SOLUTION OF OXYGEN IN URANIUM DIOXIDE. R. L. Colombo (FIAT, Turin). Nucl. Sci. Eng., 17: 309-10(Oct. 1963).

Previous calculations for the heat and entropy of solution of oxygen in nonstoichiometric uranium dioxide were extrapolated, and the partial molar heat of solution and entropy change per mole of O_2 were obtained from a least squares fit of the data. (C.E.S.)

234 STRUCTURAL TRANSFORMATION OF ZIRCONIUM PHOSPHIDE. K. S. Irani and K. A. Gingerich (Pennsylvania State Univ., University Park). Phys. Chem. Solids, 24: 1153-8(Oct. 1963).

Structural investigations were made on the phosphides of zirconium, with reference to the phosphides of the transition metal family Ti, Zr, and Hf. For the hexagonal form of β-ZrP, the unit cell expansion as a function of temperature was determined, using high-temperature x-ray diffraction. The transformation from the hexagonal β-form to the f.c.c. α-form at elevated temperatures was investigated. The unit cell dimensions of the hexagonal β-ZrP are found to increase linearly with temperature, until at a critical value in vacuum there is a slight decrease in phosphorus content and the cell suddenly collapses to the more stable cubic α-ZrP. The constancy of the hexagonal c/a value until its sudden fall to unity, for the cubic form, is indicative of a cooperative first order type of transformation. Mass spectrometric techniques were also used to study this transformation. A structural model is given to explain this transition that is a function of both temperature and pressure, involving a slight stoichiometry change. The relative high temperature stabilities are TiP < ZrP < HfP. (auth)

235 FAR-INFRARED SPECTRA OF TWO CERIUM DOUBLE NITRATE SALTS. J. H. M. Thornley (Univ. of California, Berkeley). Phys. Rev., 132: 1492-3(Nov. 15, 1963).

Far-infrared transmission experiments were carried out on cerium magnesium nitrate and cerium zinc nitrate. The energies of the first excited doublets were found to be 36.25 and 30.2k, respectively. The frequencies of the longest wavelength lattice absorptions were determined. (auth)

236 NEUTRON DIFFRACTION AND MÖSSBAUER STUDY OF ORDERED AND DISORDERED $LiFeO_2$. D. E. Cox, G. Shirane, P. A. Flinn, S. L. Ruby, and W. J. Takei (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 132: 1547-53(Nov. 15, 1963).

Neutron diffraction and Mössbauer studies of two crystallographic forms of $LiFeO_2$ were made. The ordered tetragonal form, in which there is cation order similar to that in $CuFeS_2$, becomes antiferromagnetic below 315°K. Good neutron intensity agreement is obtained with a collinear spin structure in which there is strong antiferromagnetic superexchange between Fe^{3+} ions in (001) planes, but only weak coupling between the planes. The moments are directed along the [001] axis and the magnetic symmetry is tetragonal. Identical calculated intensities are given by a second collinear structure of lower symmetry in which ferromagnetic (111) planes of moments are coupled antiparallel, but the x-ray data are not consistent with this model. However, this type of structure is realized in disordered, cubic $LiFeO_2$ below 90°K, although both the neutron scattering and the Mössbauer spectra reveal that the long-range magnetic order is far from complete. (auth)

237 QUADRUPOLE ANTISHIELDING FACTORS OF IONS. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 1637-9(Nov. 15, 1963).

Values of the quadrupole antishielding factor γ_∞ were calculated for the F^-, Br^-, Rb^+, Pr^{3+}, and Tm^{3+} ions, using the method of direct solution of the inhomogeneous Schroedinger equation for the perturbed wave functions. (auth)

238 OBTAINING ZIRCONIUM BORIDE. V. F. Funke and S. I. Yudkovskii (All-Union Research Inst. of Hard Alloys, Academy of Sciences, USSR). Prooshkovaya Met., Akad. Nauk Ukr. SSR, No. 4, 49-53(July-Aug. 1963). (In Russian)

The possibility of obtaining zirconium boride of stoichiometric composition with a slight impurity content of the initial materials (B_4C, ZnO_2) of technical purity is reported. The effect of the chemical composition and dispersity of the initial boron carbide on the chemical and phase composition of the resulting zirconium boride was studied. As in the case of titanium boride it is expedient, when obtaining zirconium boride by the boron carbide method, to use boron carbide with the maximum content of bound carbon. On obtaining zirconium boride by the vacuum thermal method there occurs a refined purification of boride from the impurities contained in the initial materials. (auth)

239 VIBRATIONAL SPECTRA OF IONIC MELTS. S. C. Wait and G. J. Janz (Rensselaer Polytechnic Inst., Troy, N. Y.). Quart. Rev. (London), 17: 225-42(1963).

The status and scope of the vibrational spectroscopy of inorganic melts are reviewed. The melts were grouped in increasing order of phase-rule complexity (as determined by the number of independently variable components). Some aspects and principles of vibrational spectroscopy applied to the qualitative and quantitative interpretation of results are described, and features of experimental work indicating differences from conventional practice are summarized. (P.C.H.)

240 PROTACTINIUM. D. Brown (Atomic Energy Research Establishment, Harwell, Berks, Eng.) and A. G. Maddock. Quart. Rev. (London), 17: 289-341(1963).

A review is presented on protactinium including the discovery and history, crystal chemistry, determination and separation, and solution chemistry of protactinium and the discovery and isolation and purification of protactinium isotopes. (303 references) (P.C.H.)

241 BARIUM XENATE. A. D. Kirschenbaum and A. V. Grosse (Temple Univ., Philadelphia). Science, 142: 580-1(Nov. 1, 1963).

Barium xenate was prepared by the addition of barium hydroxide to xenic acid. The resulting white amorphous precipitate was shown by elementary analysis to be Ba_3XeO_6. (auth)

242 NUCLEAR MAGNETIC RESONANCE IN LITHIUM CHLORIDE SOLUTIONS. R. A. Craig and R. E. Richards (Lincoln Coll., Oxford). Trans. Faraday Soc., 59: 1972-82(Sept. 1963).

Differences in Li^7 spin-lattice relaxation rate for lithium chloride solutions in water, methanol, and formic acid are due mainly to viscosity effects. With dimethyl formamide as solvent, however, there are increases in relaxation rate beyond those attributable to viscosity changes, suggesting strong specific ion-solvent interactions. Measurements at different concentrations in aqueous solutions indicate that there is no significant ionic contribution to Li^7 relaxation. The results and also the changes observed in chemical shift of solvent protons in such systems are discussed in terms of ion solvation. (auth)

243 INVESTIGATION OF $\epsilon-UO_3$. L. M. Kovba, L. M. Vidavskii, and E. G. Lavut (Moscow State Univ.). Zh. Strukt. Khim., 4: 627-9(July-Aug. 1963). (In Russian)

A crystal modification of $\epsilon-UO_3$ was prepared from mixed uranium oxides at comparatively low temperatures. The initial bright lines of $\epsilon-UO_3$ correspond to 001, 100, and 200 lines of the mixed uranium oxides, but their x-ray picture differs considerably. An attempt was made at identifying $\epsilon-UO_3$ Debye crystallogram on the basis of hexagonal $\alpha-UO_3$ nucleus or pseudohexagonal $\alpha-U_3O_8$. The results are tabulated. (R.V.J.)

244 CHEMICAL REACTIONS OF GRAPHITE. Sigfred Peterson. p.47-9 of "Nuclear Safety. Vol. 5, No. 1."

The reactions between reactor-grade graphite and air or oxygen are discussed. Observations of oxidized surfaces, oxidation in reactor channels, and reactions of graphite with other materials are described. (M.C.G.)

245 METAL-WATER REACTIONS. E. G. Bohlmann. p.51-8 of "Nuclear Safety. Vol. 5, No. 1."

Reactions of metals used to construct fuel elements with water are discussed. For aluminum, zirconium, and uranium, the energy from a chemical reaction involving 100 lb of metal could equal or exceed that from a nuclear excursion. Condenser discharge experiments, used to study the parameters that would produce or promote such a reaction, are described. The relatively negligible metal-water reaction that took place in the SL-1 incident is discussed. (M.C.G.)

246 THE EFFECT OF CHANGES IN CATALYST COMPOSITION ON THE HYDROGEN-DEUTERIUM EXCHANGE REACTION ON COBALT FERRITE. Robert George Squires, Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 140p.

The catalytic activity of the H-D exchange reaction on cobalt ferrite catalysts and the change in thermoelectric power of the ferrite during the adsorption of H and O were investigated as functions of the catalyst composition. The relationships between the semiconducting and catalytic properties of cobalt ferrite were analyzed in the light of recent developments in the electron theory of catalysis. The H-D exchange reaction was investigated on ferrite catalysts, $Co_{3-x}Fe_xO_4$, with 4 different compositions: 2 n-type catalysts with $x > 2$; and 2 p-type catalysts with $x < 2$. The activation energy increased from 19 kcal/mole to 24 kcal/mole, and the pre-exponential factor increased from 10^{30} to 10^{37} as the composition progressed from $x < 2.0$ to $x > 2.0$. The change of thermoelectric power of compressed powder ferrite pellets during the adsorption of H and O was investigated in the temperature range 88°–250°C on 2 samples of cobalt ferrite, one n-type and one p-type. At temperatures above 120°C, H was adsorbed on the cobalt ferrite as an electron donor, and O was adsorbed as an acceptor. No change in thermoelectric power was observed during the adsorption of H or O in the lower temperature (88°C) runs, indicating that little electron transfer occurs between the adsorbed molecules and the catalyst surface in this temperature range. It is concluded that the H-D exchange on cobalt ferrite occurs in 2 stages: The first stage, in which the catalytic activity increases with time, might be associated with the reduction of O on the surface of the ferrite, and the corresponding formation of OH and OD groups; In the second stage, the exchange reaction occurs with constant activity, and exchange probably occurs between H and D and the OD and OH groups formed in stage (1). (M.P.G.)

247 A STUDY OF THE FIRST POLAROGRAPHIC WAVE OF THE URANYL ION IN WATER AND WATER-ETHANOL SYSTEMS. William Ves Childs. Thesis, Fayetteville, Ark., Univ. of Arkansas, 1963. 107p.

The first wave of the polarographic reduction of the uranyl ion was investigated. The polarographic variables were studied as functions of the uranyl concentration, the concentration of added chloride, and the concentration of added acid in various ethanol-water solvent systems. Experimentally it was observed that for the reduction, U(VI) + e = U(V) the diffusion current is not a linear function of the uranyl concentration. The half-wave potential for this reduction was found to become more negative with increasing uranyl concentration. It was observed that in ethanol-rich solvents containing appreciable amounts of chloride the reduction process is not the one-electron reduction to U(V), but it is apparently a two-electron reduction to U(IV). This conclusion was drawn from changes in the product of the diffusion current constant and the square root of the viscosity and from the slope of the plot of the potential at the dropping mercury electrode vs the logarithm of the ratio $i/(i_d - 1)$. A simple model was proposed that predicted that the limiting current for the reduction to U(V) should fit an equation of the form $i_0 = k_1C + k_2C^2$ where i_0 is the observed limiting current, k_1 and k_2 are constants, and C is the uranyl concentration. This equation was found to represent the experimental data to within experimental error. This model was also shown to predict that the half-wave potential should become more negative with increasing uranyl concentration. (M.P.G.)

248 A KINETIC STUDY OF THE REACTIONS OF HYPOPHOSPHOROUS ACID WITH COBALT(III) PERCHLORATE AND CERIUM(IV) PERCHLORATE. Robert Leo Carroll. Thesis, Columbia, Mo., Univ. of Missouri, 1963. 146p.

The kinetics of the reaction of Co(III) with hypophosphorous acid was studied through a range of concentrations of H ion from approximately 2×10^{-1} M to 4 M, of Co(III) from approximately 1×10^{-2} M to 5×10^{-4} M, and of the hypophosphorous acid from approximately 5×10^{-2} M to 3×10^{-3} M. The rate expression for the kinetics through this range of concentrations was determined, and the reaction rates are discussed. The kinetics of the reaction of Ce(IV) with hypophosphorous acid was studied (25°C) through a range of concentrations of H ion from approximately 4.6 M to 1 M, of Ce(IV) from approximately 7×10^{-2} M to 1×10^{-2} M, and of hypophosphorous acid from approximately 1.5×10^{-2} M to 3×10^{-3} M. The rate expression for the kinetics over this range of concentrations was also determined, and the reaction rates are discussed. The activation energy E_a, activation entropy $\Delta S^{\ddagger}$, and the rate constants for Ce(IV) and Co(III) are tabulated. Electron transfer and oxidation mechanisms are postulated. (M.P.G.)

249 CATALYZED LAMELLAR REACTIONS OF GRAPHITE. Marceline L. Dzurus and Gerhart R. Hennig (Argonne National Lab., Ill.). p.139-42 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Most lamellar compounds of graphite form readily without the need of a catalyst because of a large favorable free energy of formation. However, for some compounds the free energy change is small and the formation of such compounds may require a catalyst. The formation of the sodium-graphite lamellar compounds was found to require a catalyst. Experiments showed that the compounds of graphite with indium chloride or with cadmium chloride contain appreciable amounts of chlorine. The chlorine is completely ionized and in both the indium chloride and cadmium chloride compounds the chlorine is the only acceptor present. The reacted chlorine can be recovered as free chlorine by thermal decomposition of the compounds. (P.C.H.)

250 SURFACE OXIDES ON GRAPHITE SINGLE CRYSTALS. Gerhart R. Hennig (Argonne National Lab., Ill.). p.143-6 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Microscope surveys of single crystals showed that below 800°C the oxidation rate of carbon atoms at edges of layer planes is at least 20 times higher than at the cleavage surfaces. The rate is proportional to the square root or lower powers of the oxygen pressure. The reactive (edge) atoms are nevertheless completely covered with surface oxides at pressures exceeding 0.1 mm and temperatures below 700°C. Above 700°C, the surface oxides cover only part of the active surfaces. It seems possible to attribute the observed reactions order of one half to a competition between two possible types of surface oxide. (auth)

251 OXIDATION OF CARBON BETWEEN 1000–2000°C. J. Nagle and R. F. Strickland-Constable (Imperial Coll. of Science and Tech., London). p.154-64 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

When oxygen reacts with pyro graphite at high flow rates and at pressures of about 0.2 atm, the reaction rate increases steeply with temperature from 1050°C to 1700°C; above this temperature the rate ceases to rise and the reaction curve becomes nearly horizontal. Since much faster rates of reaction are observed with other forms of carbon under otherwise identical reaction conditions, the pyro graphite rates must be genuine chemical rates not substantially influenced by gas phase mass transfer. In the past the reactions of oxygen at very low pressures with carbon filaments have shown that the reaction curve under these conditions reaches a maximum at a temperature of about 1100°C, which is 600°C less than the temperature at which the maximum rate with pyro graphite at a pressure of 0.2 atm was observed. The theory of Blyholder, Binford and Eyring, slightly modified, is shown to account satisfactorily for this difference between the low and high pressure results. The reactions of reactor quality graphite with oxygen were also studied. The reaction curves reach a maximum at about 1600°C in a manner very similar to those of pyro graphite, and the rate then falls appreciably between 1600 and 2000°C. The rates in this case are considerably higher than with pyro graphite, and they are certainly partly mass-transfer controlled: but the similarity in shape with the pyro graphite results suggests that, although the absolute values of the rates may be in need of considerable correction for mass transfer, the curves for reactor graphite are in broad outline of a shape determined by chemical factors. (auth)

252 STUDY OF THE OXIDATION OF CARBONS BY AIR AND CARBON DIOXIDE AS A FUNCTION OF THEIR TEXTURE AND THEIR STATE OF PURITY. F. M. Lang, P. Magnier, and S. May (Centre d'Etudes Nucleaires, Saclay, France). p.171-93 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962. (In French)

Studies were made simultaneously on the evolution of impurities and the internal porosity (morphology of pores, surface development) of carbons. Injections of fused silver under pressure permitted the evolution of the porous texture of the solid to be followed when oxidation developed. Attempts were also made to define, as precisely as possible, the conditions governing the kinetics of the oxidation of carbon (specific velocity, activation energy) in the presence of air or of carbonic gases of controlled purity. Ex-

periments were conducted on a number of samples of diverse origins (coke, graphite, wood charcoal, natural graphite, and artificial graphite), which were oxidized in certain cases, after some degassings under vacuum near 1500 C, for the dried gas; this permitted the influence of humidity to be established in air or in CO_2. (auth-tr)

253 CARBON FILMS FROM CARBON SUBOXIDE DECOMPOSITION. FORMATION KINETICS. Thomas J. Hirt and Howard B. Palmer (Pennsylvania State Univ., University Park). p.406-15 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Very pure C_3O_2 at low concentration in pure helium carrier gas decomposes at a convenient rate at temperatures between 600 and 800°C, producing a tenacious and hard carbon film on a glazed porcelain surface. Physical characteristics of the film place it in the polycrystalline graphite class. The rate of film formation is measured by recording the resistance of a film of specified length as a function of time. The measuring section occupies a small fraction in length of a uniform temperature zone. By keeping the extent of C_3O_2 decomposition low, a steady decomposition rate is achieved along the uniform zone, of which the measuring section constitutes a representative sample. Deposition kinetics were examined with respect to C_3O_2 concentration, temperature, gas flow rate, and surface-to-volume ratio. Computation of rate constants then permits deductions to be made concerning the mechanism and energetics of the decomposition of C_3O_2 and the deposition of carbon. (auth)

Organic Chemistry

254 (AD-299008) THE PRODUCTION AND DETECTION OF FREE RADICALS BY CHEMICAL AND SPECTROGRAPHIC METHODS. Final Report, October 29, 1960–October 28, 1962. Roy J. Gritter (Connecticut. Univ., Storrs). Contract DA-19-129-QM-1708. 87p.

Compounds with structures similar to those present in proteins were brought into reaction with radical-producing reagents to form intermediate free radicals. The structures and behavior of these intermediate free radicals were studied. The existence of a sulfonium radical intermediate was investigated and evidence to support the formation of this radical, as a transient intermediate in some free radical reactions with phenyl sulfide, was found. The thermal decomposition of tert-butyl peroxide in the presence of N-methyl pyrrole gave two isomeric products. Study of the tert-butyl peroxide-initiated free radical reactions of cyclohexane oxide and propylene sulfide resulted in the discovery of a type of radical abstraction and rearrangement not previously described. Thermal-decomposition products of peroxyesters were studied for identification of free radicals. One hundred and twenty-eight references are included. (M.C.G.)

255 (IS-595) METAL NITRATE COMPLEXES WITH TRIBUTYL PHOSPHATE AND WITH TRIOCTYL PHOSPHINE OXIDE. Eugene Warren Nadig and Morton Smutz (Ames Lab., Ames, Iowa). Feb. 1963. Contract W-7405-eng-82. 108p.

An infrared spectra investigation of organic solvents containing various inorganic solutes was made. The emphasis was on metal nitrate complexes with tributyl phosphate and with tri-n-octyl phosphine oxide. The infrared spectra indicated that in all solute-solvent systems studied a single complex was formed with the attachment of the solute taking place at the phosphoryl oxygen in the case of tributyl phosphate and tri-n-octyl phosphine oxide. There was no indication of an attachment to the oxygen of the P-O-C group in the case of tributyl phosphate. Empirical studies indicated that most nitrates were of the C_{3v} symmetry type with the nitrato group covalently bound through one oxygen atom to the metal. The presence of ν_4 in the region 1481 to 1531 cm^{-1} and ν_1 in the region 1290 to 1253 cm^{-1} indicated the following structure for nitrate solutes: $M-O-N\begin{matrix}O\\O\end{matrix}$. Spectra of all soluble nitrates in the organic phase showed ν_4 and ν_1 bands. A linear correlation was obtained between the ionic potential (charge of cation/ionic radius of cation) of a solute in tributyl phosphate and the P → O frequency shift. A different linear correlation was found for solutes in tri-n-octyl phosphine oxide. It would be expected that the higher the ionic potential of the solute, the stronger the bond formed between it and the solvent. From theoretical considerations the shift is interpreted as indicative of the strength of the complex formed, possibly quantitatively. The correlation of P → O shift and ionic potential is consistent with these viewpoints. A linear relation between P → O frequency shift and the covalency of the solute, measured by the frequency difference $\nu_4 - \nu_1$, was found for tributyl phosphate. A different linear relationship was obtained for tri-n-octyl phosphine oxide. These correlations are consistent with the fact that the ionic potential, which correlates with P → O shift, is directly related to the amount of covalence in a compound. For tributyl phosphate an essentially linear relation exists between the P → O stretch frequency shift and the grams of extractable species per 100 grams of complex with two exceptions: ferric chloride and ferric nitrate. Grams of extractable species per 100 grams of complex can be represented as $100\ m_1/m_1 + m_2$, where m_1 = the molecular weight of the solute and m_2 = the molecular weight of tributyl phosphate multiplied by the number of tributyl phosphate molecules attached to the metal in the complex. This relationship apparently represents a reasonably reliable means of estimating the number of tributyl phosphate molecules in the complex. For tri-n-octyl phosphine oxide the correlation of grams of extractable species per 100 grams of complex or $100\ m_1/m_1 + m_2$ versus P → O stretch frequency shift was apparently not as good as that for tributyl phosphate. The maximum distribution coefficient of a nitrate between tributyl phosphate and the aqueous phase was found to be related to both the ionic potential of the cation and grams of extractable species per 100 grams of complex. The correlations were made for the tributyl phosphate-nitric acid-metal nitrate system because of the availability of data for the maximum distribution coefficients. (auth)

256 (PAN-389/XIII) HERSTELLUNG VON MIT J^{131} MARKIERTEN DL-THYROXIN UND 3,5,3-TRIJOD-L-TYRONIN. (Preparation of DL-Thyroxin and 3,5,3-Triiodine-L-Thyroxin Labelled with I^{131}). Krystyna Russin, Andrzej Szuchnik, Andrzej Kołaczkowski, and Krystyna Witkowska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 11p.

With the help of isotope exchange, a micromethod for preparation of DL-thyroxine labeled with I^{131} and 3,5,3'-triiodo-L-thyroxine was developed. The method is suitable for production of these compounds with high specific activity. (tr-auth)

257 (PAN-390/XIII) HERSTELLUNG VON MIT J^{131} MARKIERTEN OLIVENÖL UND ÖLSÄURE. (Preparation of Olive Oil and Oleic Acid Labelled with I^{131}). Krystyna Russin, Andrzej Szuchnik, Andrzej Kołaczkowski, Krystyna

Witkowska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 19p.

A method for iodination of olive oil and oleic acid using iodine chloride labeled with I^{131} in chloroform-alcohol solution was developed. These methods can be used to give preparations with high specific activity. (tr-auth)

258 INVESTIGATION OF ACYLATED GEMINAL DIAMINES. PREPARATION OF α-AMINOACIDS LABELLED WITH ^{14}C IN THE CARBOXYL GROUP. Janos Egyed, Julia Meisel-Agoston, and Laszlo Oetvoes (Central Research Inst. for Chemistry, Hungarian Academy of Sciences, Budapest). Acta Chim. Acad. Sci. Hung., 38: 123-8(1963).

A new general method was developed for the synthesis of l-C^{14}-amino acids. Essentially, the method consists of the exchange of the carboxyl group of the aminoacid by a C^{14}-carboxyl group through a reaction cycle. Starting from a given amino acid, first the N-phthaloyl, then from this latter the chloride, further the azide derivatives are prepared. Subjecting the azide derivatives to a Curtius decomposition, a carbamic acid derivative was obtained whose phthalimide group could be exchanged by a labeled cyanide-group. The hydrolysis of the formed nitrile derivative affords the desired labeled amino acid. It was possible to prepare DL-alanine-l-C^{14} in a yield of 69.2%, DL-valine-l-C^{14} in yield of 52%, and DL-β-phenylalanine-l-C^{14} in yield of 43.5%. (auth)

259 BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE AT THE α-CARBON OF β-PHENYLINDENONE. Bernard W. Rockett, Thomas M. Harris, and Charles R. Hauser (Duke Univ., Durham, N. C.). J. Am. Chem. Soc., 85: 3491-6(Nov. 5, 1963).

Deuteration of β-phenylindenone was effected with deuterioethanol by means of sodium ethoxide at 0°C to form an α-deuterio derivative. This result is in agreement with an addition-elimination exchange mechanism, but not with one involving ionization of the α-vinyl hydrogen. (auth)

260 KINETICS OF THE REACTION BETWEEN SOLVATED ELECTRONS AND WATER IN ETHYLENEDIAMINE. R. R. Dewald, J. L. Dye, M. Eigen, and L. DeMaeyer (Max Planck Institut für Physikalische Chemie, Gottingen, Ger.). J. Chem. Phys., 39: 2388-9(Nov. 1, 1963).

Studies were made on the kinetics of the reaction of cesium-ethylenediamine solutions with solutions of water in ethylenediamine. In all cases the reaction was pseudo-first-order in the solvated electron concentration so that the rate constant could be obtained from the half-time of the reaction. A plot of the log of the pseudo-first-order rate constant vs log (H_2O) gave a straight line with a slope of unity. The second-order rate constant was found to be 24.7 ± 1.5 l mole^{-1} sec^{-1} at room temperature and gives for the decay of the solvated electron in pure water $k = 1.4 \times 10^3$ sec^{-1}. (P.C.H.)

261 MASS SPECTRA OF DIAZOCOMPOUNDS. I. DIAZOCARBONYL COMPOUNDS. A. Foffani, S. Pignataro, B. Cantone, and F. Grasso (Università, Catania, Italy). Nuovo Cimento (10), 29: 918-29(Aug. 16, 1963).

From the mass-spectrometric fragmentation pattern and from appearance and ionization potential data of diazocarbonyl compounds, evidence is given for the competitive intervention of a mechanism of direct electron impact to the diazocompound molecule and of a process of primary ionization of the carbene fragment from thermal cleavage; the relative yield of the two processes is strongly influenced by structural parameters. From energetic data typical effects of halogen and diazo-groups are put into light both on the molecular ionization potentials and on the bond-dissociation energies of the neutral molecules. A value of (8.0 ± 0.1) ev is inferred for the $COCHN_2$· radical ionization potential. Two markedly different ranges are observed for the total bond-dissociation energies of a given bond in the molecular ions; their possible structural significance in terms of electronic excitation energies is discussed. (auth)

Radiation Chemistry and Radiochemistry

Refer also to abstract 516.

262 (AD-297177) RADIATION POLYMERIZATION OF ACETYLENE DERIVATIVES. Final Report, August 10, 1961–August 10, 1962. M. E. Gutzke and W. H. Yanko (Monsanto Research Corp. Dayton Labs., Ohio). Aug. 22, 1962. Contract NObs-86072. 54p.

Exploratory research on the radiation-induced polymerization of acetylene derivatives to produce polyene polymers with useful properties included synthesis of acetylene derivatives, screening monomers for radiation sensitivity, correlation of chemical structure with sensitivity, attempts to establish optimum polymerization conditions, and characterization of the products. Fifteen acetylene derivatives representing seven compound classes were prepared, and five others were supplied by the Research and Engineering Division of Monsanto Chemical Company. Eight other syntheses were attempted unsuccessfully. A total of 48 acetylene derivatives were screened for radiation sensitivity during the year. Radiation yields with G values greater than 100 were observed with propiolic acid, G = 322; 2-butyn-1,4-dipropiolate, G = 103; neopentylene dipropiolate, G = 177; and pentaerythritol tetrapropiolate, G = 133. Other moderately radiation sensitive systems include: phenylpropiolic acid, G = 73; phenylbromoacetylene, G = 94; 2-butyn-1,4-diacetate, G = 96 and bis-1,4-(hydroxyethyloxy)-butyne-2, G = 57. In general, the acetylenic monomers exhibit good radiation sensitivity, but the products obtained appear to be of low molecular weight. Based on the screening data, radiation sensitivity was correlated with chemical structure. Among the functional groups affecting radiation sensitivity, the carboxyl group appeared especially sensitive. Presence of the hydroxyl group appeared unrelated to radiation sensitivity. Whereas monopropiolates were only fairly radiation-sensitive, all polypropiolate esters studied were very radiation-sensitive. In attempts to define optimum conditions for radiation-induced polymerization by use of radiation-sensitive acetylene derivative models, the following variables were studied: state; dose rate; temperature; and use of complexing agents and sensitizers. All affected the radiation yields, but no consistent pattern emerged. The products obtained from the above studies were mostly highly colored fluids, indicating low molecular weights. The few solids obtained were evaluated for electrical properties and resistivity values ranging from 1.6×10^5 to 10^{13} ohm-cm were obtained. However, the polymers differed little in electrical properties from the corresponding monomers. (auth)

263 (AERE-M-1008) NOTES ON THE PREPARATION WITHIN THE AUTHORITY OF THIN FILMS OF RADIOACTIVE MATERIALS. E. Furby (United Kingdom Atomic Energy Authority. Research Group. Atomic En-

ergy Research Establishment, Harwell, Berks, England). Mar. 1962. 8p.

Methods in current use for the preparation of radiation sources by the deposition of thin films of radioactive material and the development work leading to their adoption are recorded and discussed. (auth)

264 (IA-846) THE RADIOLYSIS OF ALKYL DIAMINES IN OXYGEN SATURATED DILUTE AQUEOUS SOLUTIONS. Progress Report. P. Rona and M. Anbar (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Aug. 1963. 25p.

The radiolytic decomposition of ethylenediamine and other alkyldiamines was studied in dilute aqueous solutions using Co^{60} gamma rays. Ammonia was found as the major product of radiolysis and its yield in neutral solutions is approximately equal to G_{OH}. The other major product found was glycinaldehyde. The mechanism of radiolysis involves primarily OH radicals and only at high substrate concentrations does decomposition occur also as a result of the action of hydrogen atoms. Thallous and cupric ions were found to induce radiolysis in the presence of organic scavengers. The mechanism of this effect is discussed. (auth)

265 (JINR-P-1379) RADIOKHIMICHESKIE ISSLEDOVANIYA VTORICHIYKH REAKTSII OBRAZOVANIYA ASTATINA PRI BOMBARDIROVKE VISMUTA I SVINTSA CHASTITSAMI VYSOKIKH ENERGII. (Radiochemical Investigations of Secondary Reactions of Astatine Production in Bismuth and Lead Bombardment with High-Energy Particles). V. N. Mekhedov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 14p.

The experimental data on the probabilities of the production of different At isotopes in the bombardment of Bi and Pb with protons, deuterons and of high energy α-particles are discussed. The At isotopes are obtained as a result of secondary reactions in which the disintegration products are captured. Analysis of the data on secondary reactions points to the existence of specific many-particle interactions of nucleons at high energies and clarifies the nature of this interaction. (auth)

266 (JÜL-127-PC) α-ZÄHLUNG VON PLUTONIUM-ISOTOPEN MIT FLÜSSIGSZINTILLATOREN. VERMEIDUNG VON FEHLERN, DIE VON EINER WANDADSORPTION DES PLUTONIUMS HERRÜHREN. (α-Counting of Plutonium Isotopes with Liquid Scintillators. Elimination of Errors, Due to Wall Adsorption of Plutonium). H. Ihle, A. Murrenhoff, and H. Aulich (Kernforschungsanlage. Institut für Physikalische Chemie, Jülich, Germany). July 1963. 12p.

Tri-n-octylphosphine oxide (TOPO) was found to be a suitable non-quenching complexing agent for application to internal liquid scintillation of Pu by eliminating the errors due to chemical wall-adsorption of hydrolized species of Pu-ions. The light yield and transmission properties of the (Dioxan + PPO + POPOP + Naphthalene + TOPO) liquid scintillator allow the use of conventional counting equipment as normally used with ZnS and NaI scintillation crystals. With such equipment counting plateaus with a slope of less than 0.1% per 100 V over the best range are obtained. With low-noise equipment excellent precision for absolute alpha counting can be achieved. The scintillator mixes with samples of aqueous Pu-solutions containing considerable quantities of salts and with samples of organic Pu-solutions containing organic complexing agents of low volatility. Both these types of samples cause difficulty for counting plate techniques due to self-absorption. The liquid scintillation method described is therefore favorable in the analytical evaluation of solvent extraction experiments. (auth)

267 (NP-13202) SEPARACION DE Pa^{234m} (UX_2) COMO PRACTICA DE LABORATORIO EN LA ENSENANZA DE RADIOQUIMICA. INFORME NO. 89. (Separation of Pa^{234m} (UX_2) as Laboratory Practice in Radiochemical Training. Report No. 89). O. Cristallini and J. Fiegenheimer (Argentina. Comision Nacional de Energia Atomica, Buenos Aires). 1963. 11p.

The coprecipitation of Pa^{234m} (UX_2) with benzoylphenylhydroxylamine (BPH) was studied beginning with solutions of uranium in hydrochloric acid. The separation factors Pa/Th at different concentration of HCl were determined. The results obtained are very superior to those obtained by the classical method of coprecipitation with zirconium phosphate. This fact, together with the simplicity of the method, makes it very suitable for experiments in radiochemical laboratory work. The method shows the techniques of working with isotopes of short life, the analysis of data from a source whose decay velocity decreases rapidly, and the determination of the resolution time of a counting system. (tr-auth)

268 (NP-13234) DIE REAKTION DES WEISSEN PHOSPHORS MIT TETRACHLORKOHLENSTOFF UNTER DEM EINFLUSS VON γ-STRAHLUNG UND NEUTRONEN SOWIE DER AUSTAUSCH VON PHOSPHORATOMEN AWISCHEN WEISSEM PHOSPHOR UND PHOSPHORTRICHLORID. (The Reaction of White Phosphorus with Carbon Tetrachloride under the Influence of γ Rays and Neutrons and Also the Exchange of Phosphorus Atoms Between White Phosphorus and Phosphorus Trichloride (thesis)). Dieter Perner (Berlin. Technische Universitat). 1963. 84p.

The reaction of white phosphorus with CCl_4 under the action of light, heat, and gamma radiation was investigated along with the reaction of energy-rich P^{32} recoil atoms with CCl_4, PCl_3, CCl_3PCl_3, red P, C_2Cl_6, and a polymer of chlorine and carbon are produced. In the case of hot-atom experiments only the P^{32}-containing compounds were detectable. In the action of gamma radiation on white phosphorus at room temperature, the chief reaction product is red phosphorus, while at 100°C practically no more red phosphorus is produced. The reactions appear to consist of two concurrent processes, one producing red phosphorus and the other PCl_3 and CCl_3PCl_2. The exchange of P^{32} between white phosphorus and PCl_3 was studied. (M.C.G.)

269 (PAN-431/XVII) FACTORS INFLUENCING THE ABSORPTION MEASUREMENTS ON LIQUID SAMPLES IN γ-RADIATION FIELD. Zbigniew Pawel Zagorski and Stanislaw Kosek (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 23p.

Factors influencing the measurements of extinction of the irradiated solution are divided into direct ones (dark current of photocells, Čerenkov radiation, changes of optical density of cells) and indirect ones, connected with the necessity of measurement without comparison with the solvent, influence of temperature, homogeneity of the radiation field, etc. On hand of comparison with other method of analysis during the irradiation, viz. polarography, the fields of application in obtaining kinetic curves of stable compounds during irradiation are discussed. (auth)

270 (PAN-432/XVII) PRIMARY PROCESSES IN RADIATION CHEMISTRY AS STUDIED BY MASS SPECTROMETRY. III. DETERMINATION OF THE DISTRIBUTION OF PRIMARY DECOMPOSITION PRODUCTS OF

TETRAHYDRONAPHTHALENE IN THE LIQUID PHASE. Henryk Wincel and Zbigniew Kecki (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1963. 25p.

On the basis of previously defined scheme of tetrahydronaphthalene molecule decomposition occurring under electron impact and using the simplified theory of mass spectra, the distribution of unimolecular decomposition products of ionized excited tetrahydronaphthalene molecules in the liquid phase (time interval of decomposition $\cong 1.92 \times 10^{-13}$ sec) was established. It was shown that with a decreasing of time scale of decomposition process from 10^{-6} to about 10^{-13} sec, the relative abundances of the parent ions increase about five times on account of decreasing of the relative abundances of their decomposition products, i.e., positive ions and corresponding neutral species. (auth)

271 (RRL-105) MERCURY PHOTOSENSITIZED DECOMPOSITION OF ALIPHATIC HYDROCARBONS—RADICAL DETECTION WITH ETHYL-C^{14} RADICALS. Richard A. Holroyd and George W. Klein (Mellon Inst. Radiation Research Labs., Pittsburgh). Feb. 25, 1963. Contract AT(30-1)-2310. 32p. (CONF-14-41)

From American Chemical Society 144th National Meeting, Los Angeles, Mar. 1963.

Ethyl-C^{14} radicals were utilized as a scavenger to identify and measure the yields of the radicals produced in the mercury photosensitized decomposition of propane, n-butane, isobutane, n-pentane, isopentane, neopentane, cyclopentane, n-hexane, 2-methylpentane, 2,2-dimethylbutane, and 2,3-dimethylbutane. This technique is ideal for this purpose since hydrogen atoms are available to generate the scavenger $C_2^{14}H_5$ radicals from ethylene-C^{14}, and high intensities prevail favoring combination reactions of radicals with $C_2^{14}H_5$ radicals. The relative quantum yields of the radicals (R) formed in the primary process are determined from the yields of labeled hydrocarbons, R-$C_2^{14}H_5$. For example, in the case of 2-methylpentane the dissociation yields are 58% $CH_3-\dot{C}(CH_3)-C_3H_7$, 28% $CH_3-CH(CH_3)-\dot{C}H-CH_2-CH_3$, 14% $CH_3-CH(CH_3)-CH_2-\dot{C}H-CH_3$, and <1% isohexyl plus 2-methylpentyl. It is shown that in mercury sensitization of these hydrocarbons a tertiary hydrogen atom is 350 times, and a secondary hydrogen atom 65 times, more reactive than a primary hydrogen atom. Carbon-carbon bond cleavage does not occur. The quantum yields are close to unity for most hydrocarbons studied. Mercury sensitization of hydrocarbons is a source of a variety of secondary and tertiary alkyl radicals. In reacting with these radicals, $C_2^{14}H_5$ radicals with both disproportionate and combine: $C_2^{14}H_5 + R \rightarrow R\text{-}C_2^{14}H_5$ (4) and $C_2^{14}H_5 + R \rightarrow C_2^{14}H_6 + R(-H)$ (5). Where R is a secondary radical, k_5/k_4 is found to be between 0.20 and 0.27; where R is a tertiary radical, k_5/k_4 is from 0.54 to 0.74. A linear relationship is observed between log k_5/k_4 and ΔS, the difference in entropy of the products of these two reactions. (auth)

272 (TID-19484) SOLID STATE POLYMERIZATION INITIATED BY GAMMA RADIATION. Progress Report. Herbert Morawetz, Benjamin Post, Jerome B. Lando, James H. O'Donnell, Nicholas Morosoff, and Matthew Chang (Brooklyn. Polytechnic Inst.). Oct. 1963. Contract AT(30-1)-1715. 26p.

An ESR study was made of the radioinduced solid-state polymerization of single crystals of barium methacrylate dihydrate. The results are interpreted to mean that at liquid N_2 temperature the primary radical is $(CH_3)\dot{C}COO^-$, that on warming to room temperature only part of the primary radicals add monomers, and that at 50°C a monomer abstracts a hydrogen atom from the active end of a propagating chain, transforming a propagating into a primary radical. The crystal structure of vinyl stearate was calculated, and the atomic coordinates and bond distances are tabulated. The monomer orientation in side chain crystallites of polyvinyl stearate formed by solid-state polymerizations is discussed. N-octadecyl acrylamide and N-octadecyl methacrylamide were prepared and their crystals irradiated with Co^{60} γ rays at 50°C; no polymerization was detected. The synthesis of α-fluoroacrylic acid for NMR studies of the stereoregularity of its derivatives is reported. The solid-state dehydration of phthalanilic acid and its derivatives to N-phenylphthalimides was studied. A crystallographic study was made of the topotaxy of the dehydration of phthalanilic acid, and the results suggest that the unstable phase of N-phenylphthalimide forms first and then is converted into the stable form. Preirradiation of phthalanilic acid with Co^{60} γ rays was found to accelerate the dehydration. (D.L.C.)

273 (TID-19535) EFFECTS OF IONIZING RADIATION ON VINYL FORMATE, VINYL ACETATE, 1,1-DICHLORO-2,2-DIFLUOROETHYLENE, 1,2-DIBROMOETHYLENE, AND TRIBROMOETHYLENE (thesis). Kitty Lynne Stansell (Vanderbilt Univ., Nashville, Graduate School). Aug. 1963. 102p.

Studies on the effects of ionizing radiation on substituted ethylenes are disclosing information on the influence of substitution within the compound and the phase in which it exists and the type of energy absorbed. Vinyl formate, vinyl acetate, 1,1-dichloro-2,2-difluoroethylene (DCDFE), 1,2-dibromoethylene, and tribromoethylene were irradiated. Results are presented in tables and graphs. (M.C.G.)

274 (USNRDL-TR-671) GAMMA RADIATION EFFECTS ON ISOPRENOIDS. I. SQUALENE. J. F. Pestaner and R. Y. Yahiku (Naval Radiological Defense Lab., San Francisco). Aug. 9, 1963. 27p. (AD-420985)

Squalene, a liquid hexamer having the fundamental isoprenoid molecular structure of natural rubber, was irradiated with cobalt-60 gamma rays. The squalene was radiolyzed in vacuum and the dose absorption varied from 0.13 to 2.1 megarad. Gas chromatographic product analysis showed that hydrogen and methane are produced in the greatest amounts. The values obtained were in units of G (molecules per 100 ev of energy absorbed) where $G(H_2) = 0.58 \pm 0.02$ and $G(CH_4) = 0.018 \pm 0.001$. The yields of ten other low molecular weight products were measured with a total $G < 0.003$. A relationship of hydrogen yield from the radiolysis of squalene and other simple isoprenoid structures to that of rubber was demonstrated. (auth)

275 (AEC-tr-6090) THE EFFECT OF PENETRATING RADIATION FROM RADIUM ON COLLOIDS. II. Albert Fernau and Wolfgang Pauli. Translated from Kolloid-Z., 20: 20-33(1917). 30p.

Cerium oxide sols were used in studies of the effects of aging, radium radiations, and electrolyte addition on inorganic colloids. The aging studies indicate that aging is a progressive dehydration of the particles, accompanied by a viscosity decrease, loss of coagulability as gel, and decreasing sensitivity to electrolyte precipitation. In the irradiation studies, a viscosity depression first results, followed by a large viscosity increase and ultimately gel formation. When the beta rays were screened off from the radium rays, the duration of the viscosity depression was

~5 times as long. The effects of stopping of the irradiation after an interval were studied. The gels produced by irradiation were found to be extremely stable. Electrolyte addition was found to give a coagulation course similar to that observed for irradiation. The possible mechanisms of these effects are discussed at some length. (D.L.C.)

276 (PA-TM-1029) THE HYDROLYSIS OF TETRANITROMETHANE IN AQUEOUS SOLUTION BY COBALT-60 GAMMA RADIATION. Arnim Henglein and Jurgen Jaspert. Translated by Alex Palinkas (Picatinny Arsenal, Feltman Research Lab., Dover, N. J.), from Z. Physik. Chem. (Frankfurt) [N.F.], 12: 324-34(1957). 18p. (AD-287994)

Trinitromethane with a G value of 3.73 can be formed from tetranitromethane in aqueous solution under the influence of gamma radiation. The reaction occurs through an indirect radiation effect and, during the subsequent reaction of trinitromethane, methazonic acid is formed. The formation of trinitromethane is not influenced by the presence of dissolved oxygen; the transformation decreases, however, with the increase of H^+-ion concentration. In the presence of small concentrations of a number of organic materials (ethanol, benzene, acetic ester, raw sugar), the formation of trinitromethane occurs with a G value of 5.85. (auth)

277 ION-MOLECULE REACTIONS IN THE RADIOLYSIS OF METHANOL. E. Lindholm and P. Wilmenius (Royal Inst. of Tech., Stockholm). Arkiv Kemi, 20: 255-8(1963).

Ion-molecule reactions of CH_3OH, CH_3OD, and CD_3OH were observed in a double mass spectrometer and are used to discuss the radiolysis yields from CH_3OH vapor, CH_3OD vapor, CH_3OH liquid, and mixtures of xenon and CH_3OH or CH_3OD. Measurements showed that after charge exchange with Xe^+ the methanol ion immediately dissociates: $Xe^+ + CH_3OH \rightarrow Xe + CH_2OH^+ + H$, with the following G values: $G(H_2) = 13.65$ and G(glycol) = 4.55. It is assumed that neutralization proceeds according to: $CH_3OH_2^+ + e \rightarrow CH_2OH + H$, giving $G(H_2) = 9.1$ and G(glycol) = 4.55. This assumption causes disagreement between the computed and observed G values in pure methanol vapor. It is suggested that the high G values in pure methanol vapor are explained by direct excitation followed by dissociation according to: $CH_3OH^* \rightarrow CH_2O + H_2$. To explain why direct excitation is without importance in the xenon-methanol mixture, it is proposed that as the excitation energy is absorbed by the xenon atoms it is evidently not transferred to the methanol molecules. The reason for this may be an energy difference or that transfer of excitation energy often must be considered as a slow process. The mass spectra of CH_3OD and CD_3OH were recorded after charge exchange with positive ions. At very low velocities (~5 ev) of the incident ions ion-molecule reactions could be observed. It was shown that in proton transfer, CH_2OD^+ loses D^+ and that CH_3OD^+ can lose either H^+ or D^+. In the radiolysis of liquid methanol the yields were computed assuming that only ion-molecule reactions are of importance, and that the neutralization process takes place according to the 2nd equation above and to: $CH_3OH_2^+ + e \rightarrow CH_3 + H_2O$. With liquid methanol it is evidently not necessary to consider direct excitation as a source of the radiolysis yields. The explanation may be that in the liquid each molecule cannot be considered separately. The energy is therefore absorbed by several molecules simultaneously and the energy supplied to one of these molecules is therefore comparatively small. Further, this energy will quickly be distributed among other adjacent molecules. Thus, the direct excitation may be of minor importance in a liquid although it must be considered in a gas. (BBB)

278 THE RADIATION CHEMISTRY OF DEAERATED AQUEOUS VINYLPYRIDINE SULPHATE — FERRIC SULPHATE SOLUTIONS. B. Cercek (Nuclear Institute "Jozef Stefan," Ljubljana, Yugoslavia). Croat. Chem. Acta, 35: 109-16(1963).

The mechanism of radiation chemical reactions of deaerated aqueous vinylpyridine sulfate solutions irradiated with Co^{60} gamma rays in the presence and absence of ferric sulfate were investigated. The effects of vinylpyridine sulfate concentrations and sulfuric acid on $G(H_2O_2)$ and including ferric sulfate on $G(H_2)$ and $G(Fe^{2+})$ were measured. A maximum value in $G(H_2O_2)$ at vinylpyridine sulfate concentrations about $4 \cdot 10^{-3}$ M was observed, but only a plateau was obtained in $G(H_2)$ at vinylpyridine sulfate concentrations below 10^{-3} M. High vinylpridine sulfate and sulfuric acid concentrations decrease $G(H_2O_2)$ and $G(H_2)$, which is decreased by ferric sulfate too, but its efficiency depends on the sulfuric acid concentration. $G(Fe^{2+})$ increases to a maximum value with increasing vinylpyridine sulfate and ferric sulfate concentrations, but decreases with increasing sulfuric acid concentrations. From the experimental results G(H) and G(OH) values were calculated. These and other results in this system are discussed to explain the mechanism of radiation chemical reactions. (auth)

279 THE POSSIBILITY OF OBTAINING MULTIPLY CHARGED IONS IN A CYCLOTRON BY PROTON BOMBARDMENT. I. S. Dmitriev. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1081-2(Aug. 1963). (In Russian)

Ions completely deprived of the electron shell may be obtained by proton bombardment. The cross section for multiple ionization by proton impact is significantly higher than by electrons. With acceleration in a cyclotron, the dissociation of hydrogen molecule ions, H_2^+, to H^0, and H^+ or $2H^+$ ions is significant. The protons formed are not in resonance with the accelerating electric field and move along a circle of half the radius as that for the H^+ ions. They intersect the central region of the chamber, and the proton current density close to the ion source may become very high. Protons leave the central region by multiple diffusion at energies of 1 Mev, with a chamber pressure of 10^{-5} mm Hg, only after several dozen revolutions. Proceeding through the field of higher pressure gas near the ion source, the fast ions cause ionization of the gas. If the resulting ions have a charge/mass ratio of about $\frac{1}{2}$, they begin to accelerate and are ionized. If the ion source is a mixture of hydrogen and heavier elements, stripped ions may be obtained, e.g., C^{6+}, N^{7+}, B^{5+}. The resonant magnetic field for these ions is 0.8% lower than that of H_2^+ ions. At larger radii the H_2^+ ions enter the region of small stages of accelerating high-frequency voltage and move for a long time in a circle of the same radius. Under these conditions, H_2^+ ion dissociation does not require increased gas pressure. The formula is given for calculating the multiple-ionization cross section with protons. (TTT)

280 MASS-SPECTROMETER STUDIES OF PHOTOIONIZATION OF MOLECULES AND DECAY OF EXCITED MOLECULAR IONS. M. E. Akopyan, F. I. Vilesov, and A. N. Terenin (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1083-7(Aug. 1963). (In Russian)

Photoionization of hydrazine and its alkyl derivatives, methyl, 1,1-dimethyl, 1,1-diethyl, 1-methyl, 1-n-butyl, and 1,1-di-n-butyl hydrazine, was studied with a mass spectrometer. The results showed that ionization plays a significant role in dissociation of the alkyl derivatives and a predominant role in the case of the most complex mole-

cules. In hydrazine, ionization by removal of a hydrogen atom was the only process discovered. Ions with mass numbers of 1 or 2, smaller than the mass number of molecular ions, were observed in the mass spectra of all hydrazines studied. As the complexity of the molecule increased, the role of dissociation with breaking of the N—C and C—C bonds increased. The data indicated that the O—O transfer corresponding to an adiabatic ionization potential is not vertical; thus the removal of an electron in ionization results in a change in the internuclear distances in the molecule. The photoionization yield near the threshold was small, and increased slowly with increase in photon energy. Curves of the ionization data for the compounds studied and tables of the energies of breaking of bonds and of ionization thresholds are given. (TTT)

281 ENERGY SPECTRA OF ELECTRONS REMOVED IN PHOTOIONIZATION OF MOLECULES. F. I. Vilesov and B. L. Kurbatov (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1088-93 (Aug. 1963). (In Russian)

The adiabatic ionization potentials of the majority of atoms and of many molecules were determined by spectroscopic and photoionization methods. Clarification of how the surplus energy is distributed among the positive ions and negative electrons was attempted. Aniline, methyl aniline, dimethyl aniline, naphthalene, benzene, toluene, o-, m-, and p-xylene, mesitylene, and durene were studied. The curves of electron distribution according to kinetic energy for aniline and naphthalene were qualitatively similar. When the difference between the photon ionization energy and the ionization potential of the molecules was insignificant, there was only one maximum on the curve. With further increase in photon energy, two maximums appeared in the low-energy region. In both cases the maximums were displaced toward the high-energy side with increased photon energies. New maximums appeared with even higher photon energies. Discrete losses of photon energy associated with excitation of positive molecular ions were evident. Removal of the more firmly bound valence electrons appeared to be the mechanism of excitation of the positive ions. (TTT)

282 EXCITATION OF FREE RADICALS IN FISSION OF MULTIATOMIC MOLECULES BY PHOTONS IN A VACUUM IN THE ULTRAVIOLET REGION. N. Ya. Dodonova and A. N. Terenin (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1094-6(Aug. 1963). (In Russian)

The luminescence of OH, NH_2, CN, and CHO radicals in photolysis of ammonia, hydrazine, acetonitrile, and formic acid vapors on exposure to a hydrogen lamp with a fluorite window (wavelength greater than 1250 A) was shown previously. The spectra of radicals of a series of amines, hydrazine derivatives, and other compounds formed in such a beam were studied. The spectra of methyl and ethyl amines and the hydrazine derivates showed bands characteristic of the NH_2 radicals and more intense bands of the CN radical, with wavelengths of 3883, 3871, 4216, and 4197 Å. These bands were also observed in photolysis of acetonitrile. The luminescence of NH_2 is energetically possible since the energy of splitting of the C—N bond in methyl amine, 3.5 ev, plus that of excitation of the NH_2 radical, 2.4 ev, is less than the energy of excitation of the light, 10 ev. The intensity of the CN band was linearly dependent on the intensity of the light for methyl and dimethyl hydrazines and acetonitrile, which indicates a stepwise photolysis. The CN band was several times more intense for acetonitrile than for methyl and dimethyl hydrazine when the lamp was turned on, but the latter two increased linearly with time. (TTT)

283 THE GRADUAL EXCITATION AND IONIZATION OF NITROGEN. I. I. Gromova and A. V. Yakavleva Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1097-1101(Aug. 1963). (In Russian)

It was shown previously (Phys. Z. USSR, 9: 547(1936); Matrelaly Soveshchaniya po Spektroskipii, 1: 308(1957)) that irradiation of N by the light emitted by a H lamp provided with a fluorite window generates fluorescence, the spectrum of which contains molecular ion bands and the bands of a second, positive system. In view of the importance of the interaction of N with short wave length radiation for the clarification of processes in the upper atmosphere, the fluorescence phenomena of N were investigated at low pressures, using the above-mentioned H lamp. The fluorescence was observed through a quartz window in the glass vessel in which the lamp was placed. Photographic and photoelectric methods were used for recording the fluorescence at the window or at the exit of the Hilger-type quartz monochromator. The exciting radiation was between 1250 and 1400 Å; the N pressure was varied from 0.005 mm of Hg to 1 atm. At low pressures the ion bands predominated but they were extinguished with increasing pressure. The bands of the second positive group started appearing at about 0.03 mm of Hg. Maxima were exhibited at 0.2 mm and (a flat one) at 3 to 10 mm of Hg. The fluorescent light at first filled the whole vessel but with increasing pressure, it was restricted to the neighborhood of the walls. It was assumed that the initial activation is due to foreign particles present in the vessel. O, H, and Ar were found to extinguish the fluorescence; organic vapors cause the appearance of a violet band in the spectrum of N. The excitation of the ion band was attributed to the absorption of the secondary radiation by the metastable molecules or to reciprocal collisions. (TTT)

284 RELATIVE REACTIVITIES OF POSITIONS ON BIPHENYL IN THE GENERATION OF REACTIVE SPECIES BY ELECTRON IRRADIATION AND IN SUBSEQUENT RING SUBSTITUTION. W. M. Hutchinson, P. S. Hudson, and R. C. Doss (Phillips Petroleum Co., Bartlesville, Okla.). J. Am. Chem. Soc., 85: 3358-62(Nov. 5, 1963).

A model is proposed to separate the relative reactivities of the three different positions on biphenyl in the generation of reactive species by ionizing radiation and the relative reactivities of the same positions on biphenyl in its substitution by the reactive species. The method depends on quantitative analysis of the six isomeric quaterphenyl products. Relative yields of the products from irradiation of biphenyl with electrons at 80 and 300° were obtained and used to check the model. The model fits the experimental data well. Results indicate that the net production of reactive species is not random; that most reactive species are free radicals but that some species more para- and less ortho-selective than free radicals are also formed; and that there is considerable hindrance to ortho-substitution at 300°. (auth)

285 EFFECT OF ADDITION OF CATIONS ON THE SIMULTANEOUS GRAFTING OF STYRENE TO RAYON BY GAMMA-IRRADIATION. Ikuo Suzuki and Seiji Ogawa (Tokyo Univ.). J. Appl. Polymer Sci., 7: 2067-74(Nov. 1963).

Simultaneous radiation grafting of styrene to rayon in the presence of atmospheric oxygen was accelerated when the rayon was immersed in an aqueous solution of some reducing cation. The irradiation time required for the same amount of grafting as in the case of no addition of salt was reduced by 40 min or more on the addition of $TiCl_3$, $SnCl_2$, $SnCl_4$, $NiCl_2$, $CrCl_3$, or $CoCl_2$, while $FeCl_2$ had little effect on acceleration. The acceleration is chiefly due to the de-

crease in the induction period caused by the oxygen in polymer phase. The mechanism of acceleration of grafting is discussed in relation to radiolysis of aqueous solution involving cation. (auth)

286 REACTIONS OF IRRADIATED POLYTETRAFLUOROETHYLENE RESIN. M. I. Bro, E. R. Lovejoy, and G. R. McKay (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). J. Appl. Polymer Sci., 7: 2121-33 (Nov. 1963).

Powders and compacted preforms of virgin unmelted polytetrafluoroethylene were subjected to ionizing radiation in high vacuum. The specific gravities, melt viscosities, and mechanical strengths of the irradiated samples after a standard heating cycle in air or at reduced pressures indicate that degradation is more pronounced in the presence of oxygen than in vacuum. The presence of oxygen in the excessively degraded sample was shown by electron spin resonance and pyrolysis experiments. It is suggested that some branched molecules are also formed on heating the irradiated samples resulting in a broadening of the molecular weight distribution. Primary fluorocarbon radicals of the type $\sim CF_2-\dot{C}F_2$ disappear rapidly when heated at 75°C in vacuum while secondary radicals $\sim CF_2-\dot{C}F-CF_2\sim$ are stable thermally at 200°C and disappear only slowly at 400°C. Both types of radicals react rapidly with oxygen and tetrafluoroethylene at 0°C. The reactions that occur in irradiated polytetrafluoroethylene in various atmospheres and at several temperatures are reviewed in light of the results found. (auth)

287 INFRARED SPECTRA OF IRRADIATED POLYETHYLENE. J. P. Luongo and R. Salovey (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Polymer Sci., 7: 2307-18(Nov. 1963).

The irradiation of polyethylene caused a number of molecular rearrangements in the chemical structure of polyethylene. In addition to the significant changes in the type and distribution of unsaturated groups, an infrared comparison of the radiation induced chemical changes that occur in air and in a vacuum showed that the presence of oxygen has a marked influence on the structural rearrangements that occur on irradiation. The infrared spectra of irradiated single crystals prepared by two different means indicated the location of vinyl groups in the crystals and their protection from radiation by aromatic structures. From the data, a number of reaction mechanisms are postulated that can contribute to the understanding of irradiation effects on polyethylene. (auth)

288 ELECTRON SPIN RESONANCE STUDIES OF TRANSIENT ALKYL RADICALS. Richard W. Fessenden and Robert H. Schuler (Mellon Inst., Pittsburgh). J. Chem. Phys., 39: 2147-95(Nov. 1, 1963).

Electron spin resonance methods were used to observe alkyl radicals in liquid hydrocarbon systems during irradiation with 2.8-Mev electrons. The investigations provided detailed structural, radiation chemical, and kinetic information about a large number of radicals. In general, the ESR lines were found to be narrow; considerable fine structure was observable, permitting positive assignment of the radical species. Accurate hyperfine constants are reported for 21 alkyl and cycloalkyl radicals (including several deuterated species), vinyl, 1-methylvinyl, 3-butenyl, allyl, and cyclohexadienyl radicals, and hydrogen and deuterium atoms. Except for cyclopropyl radical, all the alkyl and cycloalkyl radicals have α coupling constants in the range 21–23 G. The β coupling constants in cases where they have been rotationally averaged isotropically were found to decrease with increasing substitution of alkyl groups on the α carbon atom. In general the values for primary, secondary, and tertiary radicals appear to be represented by the splittings observed for the methyl protons in ethyl (26.87 G), isopropyl (24.68 G), and tert-butyl (22.72 G) radicals. A possible explanation for this trend is discussed. A number of examples showing a significant departure from the above isotropically averaged values were found. In several cases this departure, and the resultant strong temperature dependence of the β coupling constants, was taken as evidence for a barrier hindering rotation about the α-carbon–β-carbon bond. Splittings caused by γ protons and range from 0.4 to 1.1 G were resolved in five cases. A pronounced angular dependence of the coupling constant was demonstrated in the case of propyl radical. The angular dependence is important in considerations of the mechanism of the γ hyperfine interaction. Three radicals that do not have the usual π-electron configuration were observed: vinyl, 1-methylvinyl, and cyclopropyl. The splittings by the α protons of vinyl and cyclopropyl radicals are 13.39 and 6.51 G. The small values indicate that as the orbital associated with the unpaired electron acquires s character the coupling constant increases from ~–23 G. The coupling constants for the two conjugated radicals, allyl and cyclohexadienyl, support the theoretical prediction of negative spin density at the unstarred positions of the odd-alternant radicals. Spectra with relatively narrow lines are reported for transient species in a number of solid hydrocarbons. The radicals observed in various hydrocarbons are discussed in terms of the radiation chemical reactions expected in the systems. In most cases the radicals represent fragments that result from rupture of a single bond. In certain cases secondary reactions, such as the addition of hydrogen atoms to unsaturates, were also found to be important. The use of ESR methods in obtaining information concerning the rate of radical reactions is illustrated by two studies. In the first an activation energy of 3.3 kcal/mole was estimated for the addition of vinyl radicals to ethylene from measurements on the temperature dependence of the relative vinyl and 3-butenyl radical concentrations in liquid ethylene. In the second the kinetics of the disappearance of ethyl radicals in liquid ethane were examined in detail. The absolute second-order rate constant for the disappearance as obtained from absolute concentration and dose rate measurements was found to be 3×10^8 liters $mole^{-1}$ sec^{-1} at –175°C. The activation energy for the reaction of ethyl radicals in liquid ethane is 780 cal/mole, or essentially that for the diffusion-controlled process. (auth)

289 ELECTRON-SPIN DENSITY IN IRRADIATED ORIENTED POLYETHYLENE. Jiro Higuchi (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 39: 2366-8(Nov. 1, 1963).

Electron spin distribution in free radicals in irradiated polyethylene was calculated from the observed anisotropic hyperfine splittings currently available in electron spin resonance data. The spin density of β-carbon appears to be negative. (auth)

290 RECOIL TRITIUM REACTIONS: VARIATIONS IN HOT ABSTRACTION YIELD WITH C–H BOND TYPE. William Breckenridge, John W. Root, and F. S. Rowland (Univ. of Kansas, Lawrence). J. Chem. Phys., 39: 2374-5 (Nov. 1, 1963).

The yield of the reaction $T^* + RH \rightarrow HT + R$, from various RH molecules was measured under essentially constant conditions of tritium atom spectra. The results showed that variation in relative HT yield is clearly an important factor in the variation of HT/RT ratios, and may possibly be the only important factor. Comparison

of HT yields with corresponding dissociation energies of the RH bonds showed a generally correct correlation of higher HT yield with lower bond dissociation energies. Relative yields of hot HT per C—H bond from recoil tritium reactions with cyclopropene, propane, butane, cyclobutene, and other molecules are tabulated. (P.C.H.)

291 GAMMA IRRADIATED CROSSLINKED CELLULOSE. G. S. Park (Welsh Coll. of Advanced Tech., Cardiff, Wales, Eng.). J. Polymer Sci., Pt. B, 1: 617-20(Nov. 1963).

Investigations were made on the effects of gamma radiation on the physical properties of cellulose crosslinked with formaldehyde. The mechanism of the crosslink reaction was also studied. Solubility and viscosity, x-ray diffraction, trapped radicals, and water sorption were studied in the irradiated crosslinked fabric. It appeared that the formaldehyde crosslinking reaction occurs in the amorphous regions of the cellulose only and holds these together after irradiation when the crystalline portions are dissolved. The preferential attack on the crystalline portions is the reverse of the effect obtained by other means (with hydrolytic reagent). (P.C.H.)

292 COMPARISON OF SOLUBILITY DATA FOR IRRADIATED POLYPROPYLENE. Arthur E. Woodward (Univ. of London). J. Polymer Sci., Pt. B, 1: 621-3(Nov. 1963).

A comparison was made of previous data on the irradiation of polypropylene in a gamma source, Van de Graaff electron generator, and in a nuclear reactor. It is illustrated that when the solubility function, $S + S^{1/2}$ is plotted against gamma dose, instead of total energy deposition (gamma dose/total dose = 0.565), for the reactor-irradiated samples, close agreement between the data for isotactic annealed film specimens and those for gamma irradiated isotactic film was found for 1/r values of about 0.005 to 0.04 $Mrads^{-1}$. It was also found that data for the reactor irradiated quenched isotactic film fall close to, but below the line for gamma irradiated atactic material, yielding an intercept of 0.43. However, decided differences occur for electron and gamma irradiated atactic polymer with the intercepts varying by a factor of two. The results were found to be in contrast to the previous conclusion that atactic and isotactic polypropylene have the same G(S) value. (P.C.H.)

293 THYMIDINE-LIKE ELECTRON SPIN RESONANCE SPECTRA IN GAMMA-IRRADIATED DEOXYRIBONUCLEIC ACID. A. Ehreberg, L. Ehrenberg, and G. Loefroth (Karolinska Institutet, Stockholm and Universitet, Stockholm). Nature, 200: 376-7(Oct. 26, 1963).

The electon spin resonance spectra of gamma irradiated DNA and thymine and thymidine were found to be similar. The three outer satellites on each side are present in all three spectra. Also, the central regions have features in common. The radical structure of DNA, thymine, and thymidine is also discussed. It is noted that thymine is the main center of stabilization of radicals. (P.C.H.)

294 PRIMARY PROCESSES IN RADIATION CHEMISTRY AS STUDIED BY MASS SPECTROMETRY. II. THE STRUCTURE OF $C_7H_7^+$ AND $C_8H_8^+$ IONS FROM TETRAHYDRONAPHTHALENE IN THE GAS PHASE. Henryk Wincel and Zbigniew Kecki (Inst. of Nuclear Research, Polish Academy of Sciences, 1963). Nukleonika, 8: 215-24(1963).

The appearance potentials of the $C_7H_7^+$ and $C_8H_8^+$ ions derived from tetrahydronaphthalene by electron impact were measured. The heats of formation of these ions were estimated. Based on the energetic considerations it is suggested that $C_7H_7^+$ at the appearance potential threshold as well as at a higher energy has the symmetrical tropylium structure. In the case of $C_8H_8^+$ the structure at the appearance potential threshold is that of styrene and/or o-quinodimethane, but at the threshold of decomposition it is that of cyclooctatetraene ion. (auth)

295 ON RADICAL INITIATED CHAIN OXIDATION OF IRON(II) IN AIR SATURATED ACID SOLUTIONS CONTAINING ALCOHOLS. II. REFINED ANALYSIS OF G (Fe^{3+}) IN THE PRESENCE OF C_2H_5OH AFTER THE PULSE ELECTRON IRRADIATION. Lech Stolarczyk (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 313-17(1963).

Refined analysis of the values of G(Fe^{3+}) after the termination of the chain processes induced by the pulse electron irradiation in air saturated aqueous solutions of 2.5×10^{-4} M Fe^{2+}, 0.4 M H_2SO_4 and $0-10^{-2}$ M C_2H_5OH was performed. The value of the ratio of rate constants of the reactions of OH radicals with Fe^{2+} ions and C_2H_5OH molecules was evaluated as about 0.9 and that of the ratio of rate constants of the reactions of $CH_3C(OOH)HOH$ molecules with C_2H_5OH molecules and Fe^{2+} ions as about 0.0055. (auth)

296 INVESTIGATION OF THE MECHANISM OF RECOMBINATION LUMINESCENCE OF A NaCl—Ag CRYSTAL PHOSPHOR. V. P. Chernenko, F. N. Zaitov, and Yu. L. Lukantsever. Opt. Spectry. (USSR) (English Transl.), 15: 41-4(July 1963).

The mechanism of recombination luminescence of the phosphor NaCl—Ag was studied by a complex procedure. Some factors responsible for the complexity of the emission spectra appearing during the thermoluminescence of x-irradiated crystals were elucidated. (auth)

297 THE REACTION OF ORGANIC COMPOUNDS OF LOW MOLECULAR WEIGHT INITIATED BY COBALT-60 GAMMA-RADIATION. VII. DOSE RATE EFFECT OF RADIATION POLYMERIZATION OF METHYL METHACRYLATE. Motome Hamashima and Shinsuke Yamazaki. Tokyo Kogyo Shikensho Hokoku, 58: 352-61(Aug. 1963). (In Japanese and English)

Methyl methacrylate was subjected to polymerization reactions initiated by the Co-60 γ rays in the absence or presence of additives over the temperature range from 10 to 30°C and the dose rate effect of γ irradiation was observed. The dose rate of this work is about 3×10^{18} ev/ml/hr. The rate of the polymerization reaction and the molecular weight of the polymer thus obtained depend on the irradiation temperature and dose rate, and the overall activation energy of polymerization of the pure monomer was found to be 4 kcal/mole. The rate of polymerization of the monomer increases with increasing dose rate, but the molecular weight of the polymer decreases with increasing dose rate. Each of 50 kinds of additives was added to the monomer. The value of R_E (that is, the product of R_P and R_M, where R_P is the ratio of the polymerization rates and R_M is the ratio of the viscosity average molecular weights of the polymer with and without an additive under the same experimental conditions) remains almost constant so long as the additives possess the same kinds of functional groups and also same concentrations (0.1 mole/l). Additives thus examined are in the following decreasing order of the values of R_E: Acids and their anhydrides > Hydroxy compounds > Hydrocarbons > Ketones > Ethers > Esters > Nitrogen containing compounds > Halogenated compounds > Nitro compounds. The values of R_P, R_M, and hence R_E change with the concentration of the additive, but it seems that they are independent of the change of the dose rate of γ rays. (auth)

298 DETERMINATION OF THE PRODUCTS OF RADIOLYSIS OF TRIPHENYLPHOSPHATE. V. P. Shvedov, S. P. Rosyanov, and Yu. F. Orlov. Tr. Leningr. Tekhnol. Inst. im. Lensoveta, No. 55, 59-63(1961).

Using ultraviolet spectroscopy and paper chromatography it was found that radiolysis of crystalline triphenylphosphate (I) by γ rays of Co^{60} (1200 C) in the presence of air yields substances similar to mono- and di-phenylphosphoric acids, as well as an easily hydrolized substance, the spectrum of which in 0.05N NaOH has maxima at 235 and 287 mμ. The formation of these substances is ascribed to the appearance of free radicals on irradiation of (I). The total yield of phosphorus containing radiolysis products amounts to 0.77 mole/100 ev of the energy absorbed at an irradiation dose of 3.5×10^{21} ev/g, which indicates a high stability of (I) to γ irradiation in comparison with that of trialkylphosphates. The ultraviolet spectra of (I) and its radiolysis products are given. (Referativnyy zhurnal, Khimiya, No. 11, 1962)

299 CHEMICAL CONSEQUENCES OF NUCLEAR ACTIVATION IN SOLIDS. PART I. EFFECTS OF THE $^{32}S(n,p)^{32}P$ REACTION IN SULPHUR-CONTAINING COMPOUNDS. A. Adams and I. G. Campbell (Univ. of Manchester, Eng.). Trans. Faraday Soc., 59: 2001-9(Sept. 1963).

The behavior of P^{32} recoils from $S^{32}(n,p)P^{32}$ reaction in crystals was studied as a function of lattice composition, irradiation conditions, and post-irradiation annealing. It is suggested that oxygen atoms in the lattice act to increase the proportion of higher valency P^{32}, this action being opposed by ions such as sulfite or thiosulfate, which act as anti-oxidants in the recoil hot zone. There are considerable similarities in the annealing behavior of the P^{32} formed from the (n,p) reaction and previously studied (n,γ) recoils. The evidence supports the view that initial recoil energy plays a small part in influencing annealing behavior, and that typical annealing behavior can occur in crystals having no lattice-ion oxygen. (auth)

300 STUDY OF α/β RATIOS OF ORGANIC SCINTILLATION SOLUTIONS. I. B. Berlman, R. Grismore, and B. G. Oltman (Argonne National Lab., Ill.). Trans. Faraday Soc., 59: 2010-15(Sept. 1963).

The ratio of α-stimulated to β-stimulated luminescence, the α/β ratio, was studied in binary and ternary organic scintillation solutions. The ratio was found to vary with the decay time of the solvent and/or the solute. To explain the low fluorescence yield under α-particle excitation, transient free radicals produced along the α track are assumed to contribute to the dynamic quenching parameter. (auth)

301 CHEMICAL EFFECTS OF IONIZING RADIATION ON INORGANIC CRYSTALS. V. V. Boldyrev and L. I. Bystrykh (Tomsk Polytechnic Inst. and Tomsk State Univ., USSR). Usp. Khim., 32: 948-66(Aug. 1963). (In Russian)

Radiation-induced chemical changes in solids were analyzed, and experimental methods in studies of chemical changes in ionic crystals are discussed. Effects of preliminary irradiation of solids on the rate of topochemical reactions are reviewed. (172 references) (R.V.J.)

302 THE EFFECT OF RADIATION ON MOLECULES TRAPPED IN INERT GAS MATRICES. Richard Travis Hall. Thesis, Berkeley, Calif., Univ. of California, 1963. 155p.

A study of the first known example of an infrared photochemical reaction, the infrared-induced isomerization of nitrous acid suspended in a solid N matrix at 20°K, was performed. An accurate assignment of the fundamental vibrational frequencies in the infrared spectrum of nitrous acid was made. A normal coordinate analysis of the matrix and gas phase vibrational frequencies of light and heavy cis- and trans-nitrous acid was made, which reproduced the observed frequencies to better than 0.3%. The vibrational frequencies of the isotopically substituted molecules were calculated. By studying the effects of filtered infrared radiation on the isomerization rate of nitrous acid, it was determined that only frequencies in the range 3200 to 3650 cm^{-1} induce the cis to trans isomerization of nitrous acid. For deutero-nitrous acid the frequency range was found to be 3500 to 4100 cm^{-1}. It was found that the rate of infrared-induced isomerization of deutero-nitrous acid is $1/10$ as fast as that of light nitrous acid. A mechanism for the isomerization of nitrous acid was proposed which involves an intramolecular transfer of energy between 2 normal vibrational modes. An estimate of the quantum efficiency of the infrared-induced isomerization was made. The results indicate that the intramolecular energy transfer between normal modes is an extremely efficient process. The potential barrier to isomerization was estimated to be 9.2 ± 1 kcal/mole for nitrous acid suspended in a N matrix at 20°K and 8 to 8.5 kcal/mole for nitrous acid in the gas phase. The potential barrier was proposed to arise from interaction of non-bonding electrons in the O−N = O group. (M.P.G.)

303 THE SYNTHESIS AND IRRADIATION OF THE MEDIUM RING SULFIDES AND THEIR DERIVATIVES. Paul Friedman. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1963. 112p.

It was felt that the gem-dimethyl effect would obtain in medium ring sulfide formation, and could be taken advantage of by preparing suitably substituted dihalides. 1,9-Dibromo-5,5-dimethylnonane (I) was prepared by bis-homologation of 3,3-dimethylglutaric acid, diethyl ester, (1. $LiAlH_4$ 2. PBr_3 3. CN^- 4. H_3O^+ 5. esterification) and closed to 6,6-dimethyl thiacyclodecane in 34.5% yield. Under identical conditions (Na_2S, high dilution) 1,9-dibromononane yielded 5.7% of thiacyclodecane. In seeking a more facile and general synthesis of the gem-dimethyl dihalides, diethyl di-(4-methoxybutyl)-malonate was prepared and reduced to 1,9-dimethoxy-5,5-di-(hydroxymethyl) nonane. Bromination, hydrogenolysis of the dibromide and cleavage to 1,9-diiodo-5,5-dimethylnonane was not fully realized because of low yields in the bromination due to steric hindrance. A successful synthesis of 1,11-dibromo-6,6-dimethylnonane (II) was achieved through the reduction and bromination of 6,6-dimethylundecandioic acid (III). The preparation of III was substantially improved by proceeding through the diformylation of 2,2-di-(2-thienyl) propane. III proved a versatile intermediate, yielding 1,9-dibromo-5,5-dimethylnonane in 60% yield by reaction with mercuric oxide and bromine. 1,10-Dibromo-5,5-dimethyldecane (V) was prepared by the oxidation of 11-bromo-6,6-dimethyldecan-1-ol to 11-bromo-6,6-dimethylundecanoic acid which yielded V by reaction with mercuric oxide and bromine. II yielded 24% of 7,7-dimethylthiacyclododecane (1,11-dibromoundecane yielded 3−5% of impure sulfide), while V gave 6,6-dimethylthiacycloundecane in 22% yield (thiacycloundecane was prepared in 13% yield by the same procedure). These results appeared to substantiate the operation of the gem-dimethyl effect in the formation of medium ring thiacycloalkanes. A series of 4 medium ring sulfides, 4 derived sulfones, and 3 derived sulfoxides were irradiated by a Co^{60} source. Heptamethylene and octamethylene sulfone showed extensive decomposition. A possible mechanism for this decomposition is discussed. (M.P.G.)

304 REACTIONS OF OXIDATION-REDUCTION ACCEPTORS WITH THE PRODUCTS OF THE RADIOLYSIS OF ORGANIC SOLVENTS. V. A. Larin and N. A. Bakh (Inst. of Electrochemistry, Academy of Sciences, USSR). p.374-7 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Oxidation reactions induced in various solvents by irradiation in the absence of oxygen were followed using the conjugate pair methylene blue-methylene blue leukobase (MB-LMB) as an indicator of dye-radical interactions. With increasing concentration of the acceptor, the radiation yield, G, increased to a constant value (full utilization of available radicals by the dye) and then increased again, showing the existence of a different mechanism. MB solutions were always bleached on irradiation under N_2, the criterion of MB → LMB reduction alone being full recovery of color when O_2 is admitted to the system. Some irradiated solutions of MB, particularly in aldehydes and esters, did not regain their color; the graphs of G against log C_{MB} (where C_{MB} = acceptor concentration), plotted for such solvents, showed that G increased with increasing log C_M, up to constant values different for each solvent. The plots of $(1/G)/(1/C_{MB})$ were linear, confirming that the reactions also involve the free-radical radiolysis products of each solvent. The bleaching of MB in acetone was only 85% irreversible. The decolorization is fully irreversible in N,N-dimethylformamide and reversible in formamide. (TCO)

305 RADIATION-CHEMICAL FLUORINATION OF CCl_4 AND $C_2H_2Cl_4$ WITH INORGANIC FLUORIDES. A. V. Zimin and A. D. Verina (Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). p.382-5 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The results are given of exploratory fluorination studies under γ irradiation, using KF, CaF_2, ZnF_2, AlF_3, and SbF_3. The volatile products were removed as they were formed. The collected gaseous halogens and Cl in the fluorides were analyzed. The radiolysis of CCl_4 and CCl_4/inorganic fluoride mixtures is discussed, concluding that in vacuum the fluorination proceeds by the interaction of the fluorides with the radicals formed when CCl_4 is irradiated. In the presence of O_2, the best fluorinating agents were ZnF_2 and AlF_3; with KF, CaF_2, and SbF_3 the radiolysis reaction predominated over fluorination by a factor of 3. Only SbF_3 activated the O_2 in the zone of irradiation, leading to high yields of Cl_2 and F_2. For other fluorides the total yields of Cl_2 were ~20-21 Cl atoms/100 ev, practically independently of the fluoride itself. The fluorination of $C_2H_2Cl_4$ was assessed only by the amount of Cl present in the fluoride. The main radiolysis products were C_2H_2Cl and HCl (~6.9 mol HCl/100 ev), which are less chemically reactive than the radiolysis products of CCl_4. Vacuum fluorination of $C_2H_2Cl_4$ at room temperature is not regarded as of practical interest, owing to the low yields (0.5-3.7 atoms/100 ev) and instability of the fluorinated products, which on heating char and evolve HCl and HF. (OTS)

306 THE CHLORINATION OF PHENYLMETHYLDICHLOROSILANE(I) AND DIMETHYLDICHLOROSILANE(II) UNDER THE ACTION OF γ IRRADIATION. R. V. Dzhagatspanyan, V. I. Zetkin, G. V. Motsarev, and M. T. Filippov. p.386-9 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Silane I was chlorinated in sealed ampoules at 0 and 20°C, under γ irradiation (~120 r/sec, over 15 or 30 min), with molar ratios (n) of Cl_2 : I equal to 0.25 : 1, 0.5 : 1, and 1 : 1. In contrast to chemically initiated chlorination of I, the present reaction was one of addition of Cl_2 into the aromatic ring rather than substitution into the methyl group, the main product being a viscous oil, which by chemical and air spectroscopic tests proved to be $CH_3 \cdot C_6H_5Cl_6SiCl_2$. A small amount of CH_3-chlorinated compounds was also formed. No product in which chlorination of CH_3- and C_6H_5-groups occurred simultaneously was observed, although it might form in initial mixtures richer in Cl_2. Silane II was similarly chlorinated at 0°C, with n equal to 0.3 : 1 and 0.5 : 1, under 2 min doses of γ rays at 120 r/sec to give ~30% yields of the monochloride and 5 to ~17% yields of the dichloride, the latter becoming greater with increasing n. (TCO)

307 THE PREPARATION OF ORGANOTIN COMPOUNDS UNDER HIGH ENERGY IRRADIATION. L. V. Abramova, N. I. Sheverdina, and K. A. Kocheshkov (Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). p.394-7 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Compounds of the general formula R_2SnBr_2 (where R = n-propyl, n-butyl, n-hexyl, n-heptyl, n-octyl, and n-nonyl) were synthesized by γ irradiation of powdered Sn with the corresponding alkyl bromide, at 90-100°C, in yields of 30-165 mole/100 ev with a dose of 18-20 Mr (37-74% of theoretical yields calculated w.r.t. RBr). The yields of n-Bu_2SnBr_2 and n-Pr_2SnBr_2 increased with increasing dose of irradiation, to a maxima of 74% at 18.3 and 69 at 19.7 Mr for the butyl and propyl compounds, respectively. The energy yields decreased with increasing dose. The compounds formed under a certain induction period. Experimental details are given for: the reactions that involved the irradiation of premixed Sn powder and RBr in an ampoule; and the preparation of n-Bu_2SnBr_2 in an apparatus in which n-BuBr circulated gradually into an irradiated ampoule containing the Sn, and the reaction product and unreacted bromide passed back into the flask holding the original n-Bu_2SnBr_2 to be raised to 300-400 mole/100 ev. (TCO)

308 CHLORINE EXCHANGE BETWEEN HEXACHLOROCYCLOHEXANE(I) AND CARBON TETRACHLORIDE, UNDER THE ACTION OF γ RADIATION. L. M. Yakimenko, R. V. Dzhagatspanyan, V. I. Zetkin, B. M. Korolev, and M. P. Maksimov. p.398-402 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The behavior of purified α-, β-, γ-, and δ-isomers of I with Cl^{36} labeled CCl_4 was studied under the action of γ irradiation at 120 r/sec over 1-15 hours at ~30°C. The mixtures consisted of 250 mg of I, 8 ml of CCl_4, and 1 ml of labeled CCl_4, and the chlorine exchange was assessed by the change in the activity of I (dissolved in 2.5 ml of benzene). No transfer of Cl^{36} took place in the absence of irradiation. The activity of α-I and β-I rose to a constant value of ~1% (arbitrary units) after 5-6 hours, while that of γ-I increased to a constant ~0.6% after 8-10 hours. The activity of δ-I was 0.5% after 6 hours. At comparatively low doses of irradiation the processes involved are chiefly the chlorination of I and Cl-exchange, while further irradiation allows a 3rd reaction, loss of HCl by I (to form pentachlorocyclohexene), to proceed. The rise of the activity of I might be ascribed to a dynamic equilibrium between the processes, but is more probably due to: radiolysis of CCl_4 to CCl_3 and Cl, formation of C_2Cl_6 and Cl_2, and re-

combination to CCl_4; $RCl + \dot{C}l \rightarrow HCl + \dot{R}'\dot{C}l$, $\dot{R}'Cl + \dot{C}l \rightarrow R'\dot{C}l$, $\dot{R}'Cl + \dot{C}Cl_3 \rightarrow R''\dot{C}l$, $\dot{R}''\dot{C}l + CCl_4 \rightarrow RC + \dot{C}Cl_3$; $RCL + \dot{C}l \rightarrow R\dot{C}l$ (exchange reaction); $R\dot{C}l \rightarrow H\dot{C}l + R'''Cl$ (dehydrohalogenation). The last reaction and the chlorination reaction are in agreement with the observed considerable evolution of HCl. (OTS)

309 THE ACTION OF γ RADIATION OF Co^{60} ON SOLID HIPPURIC ACID. Ya. M. Lapinskaya, M. A. Khenokh, M. P. Votinov, V. F. Evdokimov, and V. V. Antuf'ev (Inst. of Cytology, Academy of Sciences, USSR and Leningrad Polytechnic Inst.). p.403-8 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The effects of γ radiation on hippuric acid, benzoic acid, and glycine were studied in the presence of air. PhCOOH gave rise to PhCOO· only, and glycine was radiolyzed to NH_3 and CH_2O, the extent of decomposition increasing with increasing dose of irradiation. Hippuric acid itself turned pink on exposure to γ rays, but the color disappeared on recrystallization or on heating to 130°C. The physical properties of hippuric acid remained unchanged after irradiation. The EPR spectrum showed 5 lines that corresponded to a H interacting with the N-nucleus and two other protons. The intensity of the lines rose with increasing dose. On heating the irradiated acid to 128°C one line of the EPR spectrum was seen to disappear; at 180°C only the central doublet remained, and decomposition set in at 210°C. The γ rays ionize and excite the molecules of the acid, which subsequently break up into stable free radicals. Thus the presence of the aromatic ring gives stability to hippuric acid. (OTS)

310 THE ACTION OF IONIZING RADIATION ON SOLID CARBOHYDRATES. M. A. Khenokh, E. A. Kuzicheva, and V. F. Evdokimov (Inst. of Cytology, Academy of Sciences, USSR). p.409-14 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The influence of γ oxidation on solid glucose, galactose, fructose, sucrose, lactose, raffinose, mannite, and starch was investigated. Gamma rays ionize and excite the carbohydrate molecules, which split into stable free radicals. The monosaccharides decompose to give HCHO and other compounds, but no new reducing sugars are formed. Sucrose forms fructose, HCHO, and dihydroxyacetone, but lactose gives the monosaccharide only, with high radiation doses. Hence the 4,1-bond is more stable to γ radiation than the 2,1-bond. In raffinose the γ rays break the 1,2-bond, liberate fructose and form HCHO and a compound containing a chromatic group. Mannite decomposes to give HCHO, dihydroxyacetone, an organic acid, and fructose, while starch forms a reducing compound, HCHO, and an organic acid but no glucose or maltose. Conductometric titrations of 1% solutions of the irradiated saccharides showed that the amount of NaOH required for neutralization decreased in the order starch > glucose > sucrose > mannite > raffinose. The acidity of any one solution is greater if the corresponding carbohydrate is irradiated in O_2 rather than in N_2. The radiochemical changes in solid carbohydrates were similar to those observed in the corresponding aqueous solutions. (OTS)

311 AEROSOLS FORMED DURING RADIOCHEMICAL REACTIONS. V. S. Bogdanov (Inst. of Organic Chemistry, Academy of Sciences, USSR). p.415-19 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The formation and destruction of aerosols were studied during the exposure of various saturated and unsaturated hydrocarbons. Weight concentrations of the aerosols and their ability to absorb light increased to a maximum and then decreased with increasing times of the exposure. The highest weight concentration was found in C_3H_8 (40 mg/l) for a dose of 1.75×10^{22}, and the lowest in CH_4 (1.2 mg/l) for a dose of 4.3×10^{22} ev. An increase in the beam intensity from 10 to 100 μa changed the weight concentration of the aerosol in n-C_4H_{10} from 2.3 to 7.5 mg/l (dose = 1.1×10^{22} ev), while in C_3H_8 (dose = 3.5×10^{21} ev) the concentration fell from 11 to 9.5 mg/l. The number of radiochemically changed molecules of the hydrocarbon found in the aerosol per 100 ev (G_a) increased with exposure in CH_4, passed through a maximum in C_2H_6 and C_3H_8 and decreased in all other systems studied. G_a values for the unsaturated hydrocarbons were higher than for saturated compounds. The radius of the droplets in CH_4 (exposure time = 30 min, atmospheric pressure, 20°C, intensity = 100 μa, weight concentration 1.2 mg/l) was 0.2–0.6 μ. Up to 80% of the droplets were charged with 1–10 units, half of which were negatively charged. (OTS)

312 RADIOCHEMICAL HALOGENATION OF BENZENE BY $C_2F_3Cl_3$ AND C_3F_6. A. V. Zimin, A. D. Verina, V. A. Khramchenkov, and S. V. Churmanteev (Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). p.420-5 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Radioinduced halogenation of C_6H_6 by $C_2F_3Cl_3$ was studied in static and flowing samples, and that by C_3F_6 in static experiments only. Halogenation products were separated by recondensations and were studied by chemical analysis and their physical properties. Pure $C_2F_3Cl_3$ on exposure to radiation evolved halogens ($G_{Cl_2}/G_{F_2} = 4.3$) while pure C_3F_6 gave fluorocarbon compounds ($C_{14}F_{26}$, $C_{22}F_{38}$, $C_{23}F_{42}$, $C_{39}F_{80}$) formed from $CF_2 = \dot{C}F$ and $\dot{C}F_3$. Halogenated benzenes were the main products only when high proportions of the halogenating agents were used. C_6H_6 proved stable to irradiation and, with $C_2F_3Cl_3$, gave $C_6H_5F_3Cl_2$, $C_6H_5F_2Cl_3$, $C_6H_4F_3Cl_3$, and $C_6H_4F_4Cl_4$. Halogenation was progressive as was shown by varying the exposure time. The primary products are obtained by the interaction of $\dot{C}_2F_2Cl_3$ and $\dot{F}$ (20%) or $\dot{C}_2F_3Cl_2$ and $\dot{C}l$ (80%) with C_6H_6 across the double bond. Halogenation of C_6H_6 by C_3F_6 gave products containing benzene rings and side-chains. Compounds with 1 benzene ring and a 3-C side chain were the primary products while those with side chains of more than 3-C were obtained by the interaction of C_6H_6 with a higher molecular weight fluorocarbon radical. Products with 2 or more benzene rings are secondary. (OTS)

313 SOME CHARACTERISTICS OF THE RADIOCHLORINATION OF BENZENE. L. A. Krasnousov, P. V. Zimakov, and E. V. Volkova. p.426-9 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Initiation of the chlorination of C_6H_6 by γ, β, ir, and uv radiation was studied. Irradiation of chlorine in benzene led to the dissociation of Cl_2. Since C_6H_6 is a good energy carrier, the additional energy causes the intermediate chlorination products to isomerize, thus changing the isomeric composition of the final product–hexachlorocyclohexane. With γ rays, initiation occurs throughout the solution while uv and β rays are absorbed in the outside layers of the solution. Regardless of the radiation used, the α-isomer is the main product; its amount depends on the type of radiation (γ rays–83.3; β rays–78; uv–73.8; ir 67.0%).

The percentage of the γ isomer depends to a lesser extent on the type of radiation used and increases as the temperature is lowered. Radiochlorination also occurs in the solid phase but only to 1,2-dichlorocyclohexadiene-3,5. The reaction is progressive and is not a free radical process. The suggested mechanism is: Cl_2 dissociates into Cl^+, Cl^- then reacts with C_6H_6 to give C_6H_6Cl, which combines with Cl^- to form $C_6H_6Cl_2$. This is repeated until $C_6H_6Cl_6$ is obtained. (OTS)

314 RADIATION POLYMERIZATION OF ACETYLENIC HYDROCARBONS. I. M. Barkalov, V. I. Goldanskii, B. G. Dzantiev, and S. S. Kuz'mina (Inst. of Chemical Physics, Academy of Sciences, USSR). p.455-9 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The reaction kinetics and mechanism of polymerization of phenylacetylene, hexene, and cyclohexylacetylene were studied in both bulk and dissolved monomers between 80 and −196°C, initiating the polymerization by 1.5 Mev electrons. For bulk polymerization, the yields increased proportionally to the dose of radiation, indicating the absence of inhibitors. Atmospheric oxygen increased the yield of the phenylacetylene polymer, but not those of hexene and cyclohexylacetylene, owing to the absence of the phenyl group in the latter 2 compounds. The rate of polymerization velocity (V) is directly proportional to the radiation intensity (I) and not to √I as is typical for vinyl monomers. Chain rupture is of a linear nature and is the most important feature of the reactions. The temperature dependence of V was relatively slight for all 3 monomers. Solutions in nonane and ethylacetate were also studied over a wide range of concentration; in all 3 monomers the yields of polymers differed sharply from those expected. A theory for the difference is proposed, substituting the clearly defined process of chain rupture by a single process of chain extinction or damping, for which mathematical formulas are presented. The theory accounts for the low activation energy of radioinduced polymerization of acetylenic hydrocarbons, and also explains the absence of any inhibiting action by oxygen. Mention is also made of the possibility of initiating the polymerization by peroxides. (OTS)

315 RADIATION POLYMERIZATION OF TRIFLUOROCHLORETHYLENE. E. V. Volkova, A. V. Fokin, and A. D. Sorokin. p.460-4 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The radiation polymerization of trifluorochloroethylene was carried out in stainless steel flasks. It was not possible to determine the initial velocity of polymerization but the relationship between velocity, temperature, and radiation dosage was determined over linear sections of the kinetic curves corresponding to 5−20% conversion. It was established that polymerization takes place over a wide range of dosage and that it proceeds without a significant induction period. The power index of the velocity-dosage relationship varied from 0.36 to 0.5 for higher dosages, and the relationship was characteristic for chain reaction processes. The presence also of a radiation after-effect was found, which lasted over a period of 2 days. Between −21 and +60°C the rate of polymerization increased initially to a maximum at 35°C and then fell off. Over the temperature range studied, the radiation yield amounted to 27,000 mol/100 ev absorbed energy for a dose of 3×10^3 rad/hr. On increasing the temperature from 0 to 35°C, a reduction in the molecular weight of the polymer was observed and this value was also reduced at higher doses. The experiments indicated that radiation polymerization of trifluorochloroethylene takes place by a chain process, originated by a radical mechanism. (TCO)

316 CERTAIN SPECIAL FEATURES OF THE RADIATION POLYMERIZATION OF TETRAFLUORETHYLENE BY THE ACTION OF β AND γ RADIATIONS. E. V. Volkova, A. V. Fokin, P. V. Zimakov, and V. M. Belikov. p.465-9 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Irradiation of TFE in the liquid phase was carried out at 20−25°C using $CHCl_3$ as the solvent with a dose-rate of 11 rad/sec. Conversion of monomer increased with increase of dosage and concentration of monomer. The polymer obtained (PTFE) contained up to 2% chlorine, which was explained by the fact that the $CHCl_3$ also participates in the reaction by interaction of radicals and chain breakage in the polymer, resulting in low-molecular weight PTFE. Experiments in the solid state were carried out from −80 to 0°C with dosages of 1×10^5 and 1×10^4 rad. Almost total conversion of monomer occurred after 200 min at −80°C and after 20 mins at 0°C. Exceptionally large yields were obtained in comparison with similar reactions of other unsaturated compounds. The existence of a radiation after-effect was confirmed, which continued over several hours after removal of the radiation source. Experiments in the gas phase showed the presence of an induction phase extending over several hours. After the appearance of solid PTFE the reaction velocity was increased. The temperature was maintained at 20−25°C and a Sr^{90} β source was used with a dose-rate of 5 rad/sec. Results indicated a high tendency of TFE towards radiation polymerization with a high yield (approx. 10^6 mol/100 ev absorbed). (TCO)

317 RADIATION POLYMERIZATION OF ALLYL SILANES. A. V. Topchiev, I. N. Lyashenko, N. S. Nametkin, L. S. Polak, M. P. Teterina, A. S. Fel'dman, and T. I. Chernysheva (Inst. of Petrochemical Synthesis, Academy of Sciences, USSR). p.477-83 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

A study was made of the radiation polymerization of organosilicon compounds in order to explain the mechanism of the process. Mono-, di-, and triallyl silanes were subjected to γ radiation from Co^{60} at an intensity of 3.4×10^6 ev/cm³ sec at 100°C. A similar series of tests was carried out using benzoyl peroxide as inhibitor. Reactivity of the monomers increased with increasing number of the allyl groups. Spectra of polydiallylethylsilanes showed that the Si−H bond was preserved and that polymerization occurred only at the expense of the double bond of the allyl group, in contrast to polymerization of diallyl silane in the presence of platinized carbon, where new Si−C bonds were formed. The radical mechanism of the process was confirmed. Solid, insoluble copolymers with acrylonitrile were obtained, which did not melt below 300°C. The molar ratio of the organosilicon component of the copolymer to the acrylonitrile component increased with its increase in the initial mixture, the dependence being stronger at lower dosages. Examination of the spectra showed differences in structure between the copolymers of acrylonitrile with diallylethyl silane and ethylphenyl silane. Copolymerization with styrene was studied, showing that the yields of copolymer increased with dosage up to a constant maximum of 50−60% for a dose of $28-42 \times 10^{20}$ ev. The dependence of yield, composition, and molecular weight on the composition of the initial mixture was also studied. It was concluded that polymerization proceeded by a radical mechanism. (OTS)

318 COPOLYMERIZATION AND GRAFTING OF SYLVAN UNDER THE ACTION OF γ RADIATION. Kh. U. Usmanov, R. S. Tillaev, and U. N. Musaev (Tashkent State Univ.). p.484-9 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Copolymers of acrylonitrile and sylvan were obtained by the action of γ radiation from Co^{60} on various mixture ratios in sealed glass ampoules. It was found that the yield of copolymer increased with increasing dosage and also with increasing acrylonitrile content. Physicochemical tests established that the copolymer consisted of soluble and insoluble portions. Chemical analysis and investigation of the spectra established the presence of nitrogen and the fact that it influenced the formation of copolymers. Investigation of the thermomechanical properties showed that the copolymers can exist in all three physical states. Radiation polymerization of sylvan only took place in the presence of sensitizing solvents such as CCl_4,and $CHCl_3$. This is explained by the formation of free radicals by the solvents, thus initiating polymerization. Grafting polymerization was studied by using chlorinated polyvinyl chloride (perchlorovinyl) with a molecular weight of 51640 and a chlorine content of 62.3%, mixed with sylvan in sealed glass ampoules and subjected to a γ dosage of 1–1.5 Mr. The results showed that in order to reduce the quantity of homopolymer formed the system must be chosen such that the basic polymer is more radiosensitive than the grafting monomer. A study of the physical properties of the grafted polymers obtained from sylvan and perchlorovinyl showed that lacquers were formed in a mixture of acetone and dichlorethane, which are stable to bending and shock and are also hydrostable. (OTS)

319 THE STUDY OF GRAFTED COPOLYMERS OF NATURAL SILK AND CAPRONE OBTAINED BY MEANS OF γ IRRADIATION. S. A. Azimov, N. V. Kordub, S. I. Slepakova, and Kh. U. Usmanov (Inst. of Physics and Tech., Academy of Sciences, USSR). p.490-6 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Acrylonitrile, styrene, and methylmethacrylate were grafted to silk and caprone while subjected to γ irradiation from a 1350 C Co^{60} source. Optimum radiation dosages were found to be 1×10^6 r for acrylonitrile and 5×10^6 r for styrene and methylmethacrylate, and the extent of grafting was found to depend on the concentration of monomer in the solvent. The nitrogen content of the grafted silk was somewhat reduced with increasing dosage. Analysis of the grafted copolymers was difficult because of their insolubility in cuprammonium solution and other solvents. It was established that the wetting properties of the grafted polymers were better than those of the original fibers. Other properties investigated showed that the grafted copolymers are insoluble in the usual solvents and that the copolymer of silk and acrylonitrile is dyed better with vat dyestuffs. The integral heats of wetting are considerably reduced and the resistance to breakage of the fibers is increased. Evidence was found for the introduction into the macromolecule of silk of hydrophobic groups. Acrylonitrile and styrene grafted to a crepe-de-chine material produced a tougher and heavier fabric, unchanged in external appearances. (OTS)

320 RADIATION GRAFTING OF POLYMERIC CHAINS TO THE SURFACE OF MINERAL PARTICLES. B. L. Tsetlin, S. R. Rafikov, L. I. Plotnikova, and P. Ya. Glazunov (Inst. of Elemental Organic Compounds, Academy of Sciences, USSR and Inst. of Physical Chemistry, Academy of Sciences, USSR). p.497-500 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Experiments were carried out in attempts to form and graft polymer chains to the surface of mineral powders for use in filters. ZnO, MgO, and BeO powders were exposed to the vapor of methylmethacrylate at a temperature of 100°C in thin-walled glass ampoules while the entire apparatus was rotated by an electric motor. The radiation source was a 700 kv electron accelerator. There was no evidence for the formation of grafted polymers in the control, nonirradiated experiment, but with a radiation intensity of 1.2×10^{18} ev/cm^3 sec and an exposure time of 75 min, 51.3% by weight on MgO of total polymer was formed, with 20.7% as grafted polymer. Results for BeO with 6×10^{18} ev/cm^3 sec and only 5 min irradiation time yielded 24% of the grafted polymer. The relationship between total quantity of polymer formed and intensity of radiation was shown to correspond to a bimolecular mechanism for rupture of kinetic chains due to recombination of the growing macroradicals and confirmed the radical mechanism of the polymerization process. Experiments carried out with ZnO did not lead to positive results. This is explained as being due to the property of electron semiconduction, so that the ion-radical of O^- formed is an acceptor of free electrons and its concentration is quite small in ZnO. (OTS)

321 A STUDY OF RADICAL RECOMBINATIONS IN IRRADIATED TEFLON. Yu. D. Tsevetkov, Ya. S. Lebedev, and V. V. Voevodskii (Inst. of Chemical Physics, Academy of Sciences, USSR and Inst. of Chemical Kinetics and Combustion, Academy of Sciences, Siberian SSR). p.521-5 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The kinetics of the recombinations of fluoroalkyl (R) and peroxide (RO_2) radicals, formed when polytetrafluoroethylene (teflon) is irradiated with γ rays, in vacuum or under O_2, were studied. EPR spectroscopy was employed to follow the reactions in specimens in which the degree of crystallinity, α, was 46 or 74%. The reactions were always of the 2nd order, but the velocity constants (k^0) depended on α. Thus for R radicals, with α = 74%, $k^0 = 10^6$, and with α = 46%, $k^0 = 10^{-3}$ cm^3/sec. A linear relation was observed between log k^0 and E_{eff}, the effective activation energies, which were between 30 ± 3 and 65 ± 5 and between 10 ± 2 and 26 ± 3 kcal/mole for $\dot{R}$ and $\dot{R}O_2$ radicals, respectively. The pre-exponential constants were anomalously high. To explain the observed phenomena, it is suggested that the activation energy, which apparently depends on the potential barrier for the rotation of polymeric chain segments, decreases with increasing temperature (180–270°C for $\dot{R}$, and 110–200°C for $\dot{R}O_2$, for teflon irradiated under oxygen). (TCO)

322 INVESTIGATION OF RUBBER STRUCTURIZATION UNDER THE ACTION OF ACCELERATED ELECTRONS. Z. N. Tarasova, B. G. Dzantiev, E. V. Egorov, M. Ya. Kaplunov, S. B. Petrova, V. S. Sobolev, and B. A. Dogadkin (Inst. of Chemical Physics, Academy of Sciences, USSR). p.569-75 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Natural butadiene-styrene and carboxylate rubbers were investigated. The energy of the electrons was 0.6, 1.6, and 2 Mev. The specimens were 0.02–0.3 mm thick films, 60 × 60 × 1 mm plates, and 10 mm thick washers. Irradiation in the free state in air from an accelerator (0.2–0.8 megarad/

sec) showed less destruction than that from a Co^{60} source in inert atmosphere. In natural rubber, destruction was much greater in the first case. In filled natural rubber it was less in the first case, but in pre-vulcanized mixtures of carboxylate rubber it was equal in both cases. Thermomechanical stability of electron-irradiated vulcanized rubbers was about 4 times as high as that of Co^{60} irradiated rubbers. Those of carboxyl containing rubbers showed high strength and wear resistance (abrasion index = 115 cm^3/kwh for nonfilled rubbers irradiated with 24 megarad and 200 cm^3/kwh for nonfilled sulfur rubbers). The chemical relaxation curve of the rubbers shows destruction and re-grouping of salt bonds in its initial part. (OTS)

323 RADIATION AGING OF RUBBERS IN STRESSED STATE. A. S. Kuz'minskii, L. S. Fel'dshteyn, E. V. Zhuravskaya, and L. I. Lyubchanskaya. p.576-80 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Stress relaxation of rubbers was investigated by means of an axial compression relaxometer. The compression degree was 20%. Specimens were irradiated by a Co^{60} source, the dose being varied from 0.5 to 1 Mr/hr. The specimens consisted of vulcanized natural, butadiene-nitryl, sodium-butadiene, and butadiene-styrene rubbers. Structurization and destruction outputs are compared. The presence of anti-radiation substances (N-phenyl-N'-cyclohexyl-p-phenylenediamine and N,N'-diphenyl-p-phenylenediamine) in the quantity of 5% by weight did not affect the chemical relaxation rate but slightly affected the rate of accumulation of residual deformation and decreased considerably the rate of structurization. The rate of residual deformation was decreased by anti-radiation substances only in the case of irradiation in air but not in vacuum. (TCO)

324 THE EFFECT OF IONIZING RADIATIONS ON CABLE RUBBERS AND STRUCTURES. G. A. Blokh, V. L. Karpov, Yu. M. Malinskii, L. P. Ol'shanskii, and M. S. Khloplyankina (Inst. of Chemical Tech., Dnepropetrovsk, USSR and Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). p.581-8 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Specimens were irradiated by a Co^{60} source. Up to a dose of 50 megarad the properties of rubbers changed relatively little. At higher doses, relative elongation decreases to less than a third and strength diminishes. Above 100 megarad complete destruction of rubberized fabric in cables was observed. In insulating rubbers strength decreases considerably, especially with 200 megarad. An increase of the dose to 350 megarad increases the strength again. In hose rubber strength drops by 25-30% with 50-100 megarad, but between 100 and 300 megarad it became higher than initial strength. Hardness increased with the dose. Relative elongation was below standards for doses higher than 50 megarad. Properties of rubbers placed in water or in vacuum (with 50-100 megarad) change much less than those of rubbers placed in air, which indicates the participation of oxygen in the processes caused by irradiation. Insulation rubber was more stable than hose rubber when subjected simultaneously to 70°C and 0.7 megarad/hour during 70 hours. Electrical insulation properties of all rubbers were below standards beginning with 50 megarad. (OTS)

325 THE WELDING OF TEFLON AND OTHER POLYMERIC MATERIALS BY THE LOCALIZED ACTION OF NEUTRON IRRADIATION. I. M. Barkalov, V. I. Gol'danskii, B. G. Dzantiev, and E. V. Egorov (Inst. of Chemical Physics, Academy of Sciences, USSR). p.616-20 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

A simple method for the localization of thermal-neutron effects in the radiation welding of polymeric and other materials was developed: the parts to be joined are treated with compounds of boron or lithium. Boron concentration (determined photometrically) in the surface layer was 1-12 mg/cm^2. There is an optimum dosage for maximum strength. The welding effect cannot be due to uniform heating of the layer and is attributed to localization of the heating effect in the tracks of the strongly ionizing particles produced. A variant of the method was patented in which the surfaces to be joined have a film of polystyrene containing 1% by weight of boron, an irradiation time of 2-3 hours (longer times reduce strength) and doses in the film and in the bulk of the joined materials of 500-800 and 40-60 megarad, respectively, the following joint strengths (kg/cm^2) were obtained: teflon with teflon, polyethylene, aluminum, and quartz, 90-110, 90-100, 120-130, and 80, respectively; polyethylene with polyethylene and aluminum, 130-140 and 110-135, respectively; aluminum with polymethylmethacrylate 120-130. (TCO)

326 THE EFFECT OF RADIATION ON SEMICONDUCTING POLYMERIC MATERIALS. G. V. Gulyaev, B. E. Davydov, B. A. Krentsel', I. I. Patalakh, and L. S. Polak (Inst. of Petrochemical Synthesis, Academy of Sciences, USSR). p.621-4 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The effects of γ and electron irradiation on polymers based on polyacrylonitrile (PAN) were studied to determine the nature of such materials. Powdered specimens were prepared by catalytic or radiational polymerization; a polyacrylonitrile fabric was also tested. The specific electron conductance (σ, 10^{-10} $ohms^{-1}$ cm^{-1}) of hot-pressed (15000 atm, 350°C) radiation polymerized PAN was lower than that of catalytically polymerized PAN (~2.6-3.6) and decreased, by a factor of 10-15, with increasing power of the dose used to induce polymerization (10^6 r, the rates were varied from 28 to 140 r/sec cm^3, at 25°C). The σ of catalytic PAN polymerized at 28 r/sec cm^3, increased on irradiation with increasing doses, up to ~10 and ~5, respectively, at 5 Mr; further increase was only slight. The σ of PAN polymerized at 75 and at 140 r/sec cm^3 was unaffected by irradiation. The energy of activation (= 0.4 ev) remained constant in all cases. The specific conductance of PAN fabric increased on irradiation, from ~10^{-5} at 0 to ~10^{-3} ohm^{-1} cm^{-1} at 140 Mr, while the energy of activation fell from 0.33 to 0.2 ev. Similar effects were observed by subjecting the fabric to 0.7 Mev electrons. The various changes observed in the semiconducting polymers on irradiation are ascribed to differences in the macrostructure of the polymer. (OTS)

327 MECHANISMS OF GAS FORMATION PROCESSES DURING THE RADIOLYSIS OF POLYMERS AND LOW-MOLECULAR WEIGHT COMPOUNDS. A. B. Taubman, L. P. Yanova, R. S. Maslovskaya, and P. Ya. Glazunov (Inst. of Physical Chemistry, Academy of Sciences, USSR). p.625-8 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Water and n-octane were irradiated with fast electrons accelerated at 700-750 kv; the doses were measured by the ferrous sulfate method. For both materials the quantity of gas evolved altered very slowly, and the temperature

coefficients remained practically constant, within wide intervals of temperature both above and below their melting points. It was concluded that the change in the gas formation kinetics in the phase transition region is independent of the nature of the irradiated material and depends only on the conditions under which the gaseous degradation products are formed and liberated during the radiolysis. The results also confirmed that, up to the moment when new gas phase nuclei form, the radiolysis reaction is reversible. Thermomechanical curves drawn for polybutylmethacrylate specimens, which had been previously irradiated with identical doses but at different temperatures indicated that destruction of the polymer chains depends not only on the direct radiation reaction, but also on internal stresses produced in the material as a consequence of the formation and delayed liberation of the gaseous radiolysis products. In some cases the formation of increased quantities of gas at higher temperatures does not aggravate the destruction of the polymer because the increased mobility of the chains enables the internal stresses to relax. (TCO)

328 CONCERNING THE DAMAGE OF POLYSTYRENE BY IONIZING RADIATION. E. E. Baroni. p.629-33 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The reactions occurring when polystyrene is irradiated with α and β rays in the presence of atmospheric oxygen were investigated, using compounds of Po^{210} and of Ce^{144}-Pr^{144} as the radiation sources. No difference was observed in the behavior of pure polystyrene and polystyrene adulterated with luminescent materials when irradiated. Surface layers of the polymer were oxidized during irradiation, and inside the sample, where oxygen and moisture were absent, condensation into three-dimensional products occurred. Peroxides, aldehydes, and carboxylic acids were detected in the oxidized portions. Microscopic examination revealed the formation of cracks, along which minute gas bubbles frequently accumulated, inside the polymer. An apparatus consisting mainly of a capillary tube, containing a mercury thread, attached to a glass ring, in which the radiation source and the polymer sample were located, was used to determine the amount of oxygen absorbed by the sample under the action of β radiation. (OTS)

329 THE ACTION OF Co^{60} γ RADIATION ON PERFLUORODIENES. V. A. Khramchenko and A. V. Zimin (Karpov Inst. of Physical Chemistry, Academy of Sciences, USSR). p.634-7 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The effects of Co^{60} γ radiation on perfluorooctadiene at 60°C and on perfluorododecadiene at 18-25°C were studied under vacuum in sealed molybdenum glass ampoules. The doses were 0.948×10^{22} and 1.43×10^{22} ev/g respectively. After irradiation the liquid phases were fractionated and the light fractions were identified by cryoscopic determination of their molecular weights and by their molar refractions. Comparison of the infrared spectra of the heavy fractions with those of the original materials indicated that the heavy fractions consisted of materials having molecular weights three times as great as those of the original dienes, and each trimer molecule contained half as many double bonds as were present in three molecules of the original material. Infrared spectra of the trimers also indicated that a double bond was present in the group $R_F-CF-CFR_F'$, the presence of the group $-CF_3$, and the formation of a cyclic structure. From the results it was concluded that the following radicals were formed during irradiation: $CF_2-CF-(CF_2)_n-CF-CF_2$, $CF_2-CF-CF-(CF_2)_{n-1}-CF-CF_2$, $CF_2-CF-CF-(CF_2)_{n-1}-CF-CF_2$, and $CF_3-CF-(CF_2)_n \cdot CF-CF_2$; all four radicals probably participate in the formation of the trimers. (OTS)

330 NATURE OF THE REVERSIBLE ACCELERATION OF MECHANICAL RELAXATION PROCESSES IN POLYMERS UNDER IRRADIATION. Yu. S. Lazurkin, M. A. Mokul'skii, and M. B. Fiveyskii (Inst. of Atomic Energy, Academy of Sciences, USSR). p.638-41 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The acceleration of creep in nitrile rubber irradiated in a nuclear reactor was studied. Samples of the test material were stretched under constant load for 45 hours to attain equilibrium deformation, almost all the deformation occurring during the first 10-20 minutes; other samples were stretched for 16 min. The stretched samples, still under load, were irradiated at intensity 2×10^4 rad/sec, whereupon creep was initiated at the rate of 4×10^{-3} sec^{-1} in both cases. The results indicated that the acceleration of creep and relaxation in resins was caused by rupture of lattice bonds. Efficiency of the destruction process was evaluated for the analysis of chemical relaxation. By means of the kinetic theory of resin elasticity an equation was derived relating the rate of creep under irradiation to the number of bonds rupturing per second in 1 cm^3 of material. Substituting into this equation the experimental data for the nitrile rubber, natural rubber, and polyisobutylene, the numbers of bonds rupturing per 100 ev of absorbed energy were estimated to be 3, 4, and 19, respectively. (TCO)

331 RADIATION-CHEMICAL ACTIVATION OF THE SURFACE OF SOLID POTASSIUM SULFATE. V. I. Spitsyn and I. E. Mikhaylenko (Inst. of Physical Chemistry, Academy of Sciences, USSR). p.642-5 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Potassium sulfate was activated with S^{35}. Increase of the activity of the sulfate altered the degree of isotope exchange in the system $K_2SO_4-SO_3$, which rose first to a maximum at the activity of 2.3 $\mu C/g$, passed through a minimum at 61 $\mu C/g$ and then rose again. The degree of isotope exxhange rose also with the duration of storage in spite of the reduction of radioactivity with time. External irradiation with electrons, equivalent to activities up to 50 $\mu C/g$, did not produce the effects observed in S^{35}-activated K_2SO_4. The activated sulfate adsorbed more methanol than the unactivated compound, indicating higher defect density at the surface; this conclusion was confirmed by electron microscopy. External irradiation with electrons produced lower surface defect density than did activation. The crystal structure and the particle size of K_2SO_4 were not affected by activation. (OTS)

332 EFFECT OF RADIATION ON SORPTION PROPERTIES OF BARIUM SULFATE. V. I. Spitsyn and V. V. Gromov (Inst. of Physical Chemistry, Academy of Sciences, USSR). p.646-50 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

The adsorption of an aqueous solution of methylene blue on precipitated $BaSO_4$ was reduced by activating the sulfate with S^{35} but it rose on adding radium (3.0×10^{-7} $\mu C/g$) to $BaSO_4$. The converse was found for the adsorption of an aqueous solution of acid orange on $BaSO_4$: radium strongly reduced the adsorption while activation with S^{35} increased it. This behavior was due to the positive charging of $BaSO_4$ surface by the β emission of S^{35} and the negative charging by the α emission of radium. The charged surface of the

sulfate attracted preferentially the dye with the opposite charge (methylene blue and acid orange have oppositely charged dye ions). NaCl added to the dye solutions reduced the difference between the adsorption on activated and unactivated $BaSO_4$. When the S^{35}-activated $BaSO_4$ was stored for 100–200 days, the adsorption of both dyes was not greatly affected because structural changes on the surface occurred immediately after activation; the observed small reduction of the adsorption with time was due to the polishing effect of the β emission acting for a long time. A similar polishing effect was found on irradiation of the unactivated $BaSO_4$ with 800 kev electrons or 1.5 Mev protons, the effect being stronger for lower dose rates. (TCO)

333 FREE RADICALS AND ELECTRICAL PHENOMENA IN IRRADIATED SOLIDS. E. L. Frankevich and V. L. Tal'roze (Inst. of Chemical Physics, Academy of Sciences, USSR). p.651-55 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Paraffin wax and polyethylene were irradiated with 1.6-Mev electrons (about 10 megarads in the case of polyethylene) below 180°K. On subsequent heating the electrical conductivity σ peaked at the same temperatures (300°K for paraffin wax and 360°K for polyethylene) at which the concentration of free radicals, produced by electron bombardment, fell to nearly zero. It is suggested that electrons and holes initially trapped by free radicals are liberated at the temperatures of the conductivity peaks (in the case of polyethylene there were two peaks corresponding to the two-stage radical annihilation: first the alkyl radicals partly recombined and were partly converted into allyl radicals, next the allyl radicals disappeared). The trap depth was estimated from the slope of the $\log \sigma = f(1/T)$ curve to be 0.6 ev in the case of paraffin wax. Nonuniform heating of paraffin wax and polyethylene irradiated (0.1–100 megarads) at low temperatures produced transient inhomogeneities of space charge due to local carrier liberation. The inhomogeneities appeared as voltages up to 100 v across the samples. (OTS)

334 AN EPR STUDY OF THE PROPERTIES OF HYDROGEN ATOMS AND OF DEFECTS FORMED ON THE IRRADIATION OF SILICA GEL. V. B. Kazanskii, G. B. Pariskii, and V. V. Voevodskii (Inst. of Chemical Physics, Academy of Sciences, USSR). p.656-9 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Silica gel was investigated because of its special adsorption and catalytic properties. The gel had a specific surface area of 200 m^2/g and contained less than 0.1% Fe and Al impurities. It was irradiated with Co^{60} γ rays in vacuum at −196°C and at room temperature with doses of 5–10 megarads. After irradiation at −196°C the EPR spectrum (recorded at the same temperature) indicated the presence of radiation defects and free hydrogen atoms, the latter being formed by radiolysis of the surface OH groups; the H-atom concentration increased with the temperature (200–500°C) to which the gel was heated before irradiation. On vacuum heating to −150 and −120°C after irradiation, hydrogen atoms recombined slowly into molecules, the recombination being hindered by the location of atoms in deep pores or microcracks in the gel surface. Heating to −150 and −120°C in ethylene and oxygen removed the free hydrogen atoms by chemical reactions as well as by recombination. Vacuum heating to 200–300°C for 8 hours, followed by vacuum irradiation at room temperature, gave a quintuplet EPR spectrum with a g-factor identical with that of phenyl picryl hydrazyl. The hyperfine structure of the spectrum was due to the interaction between an unpaired electron of a radical and protons of four OH surface groups. Vacuum heating of silica gel to 500°C followed by room-temperature irradiation in vacuum, generated volume defects similar to F-centers and consisted of electrons captured by oxygen vacancies. (OTS)

335 THE USE OF IONIZING RADIATION IN INVESTIGATION OF TOPOCHEMICAL PROCESSES. S. Z. Roginskii, G. M. Zhabrova, V. A. Gordeeva, E. V. Egorov, B. M. Kadenatsi, and M. Ya. Kushnerev (Inst. of Physical Chemistry, Academy of Sciences, USSR and Inst. of Chemical Physics, Academy of Sciences, USSR). p.668-73 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

A study was made of the differences between the topochemical processes of thermal decomposition and of decomposition, using 0.6–2 Mev electrons. The substances decomposed were copper oxalate ($CuC_2O_4 \cdot 1/2H_2O$) and nickel oxalate ($NiC_2O_4 \cdot 2H_2O$), which were prepared by precipitating nitrate solutions with oxalic acid at 50°C; the samples were in the form of thin layers of powder. Thermal decomposition in vacuum at 280°C yielded 85% Cu + 15% Cu_2O and 95% Ni + 2.0% NiO + 3% undecomposed residue. Thermal decomposition in air at about 300°C yielded 50% CuO + 50% Cu_2O and 100% NiO. Electron irradiation ($3.6 \times 10^9 - 3.3 \times 10^{10}$ rad) at 100°C yielded usually pure metals with large (10–40%) residues of undecomposed oxalates; the metal yield increased with the radiation dose. Strong preliminary irradiation (at least 0.6×10^9 rad) accelerated strongly the subsequent thermal decomposition in vacuum. The mechanisms of thermal and electron-bombardment decomposition were the same; holes generated by heat or irradiation neutralized partly or completely the double charged oxalate ions and then moved to the surface and were emitted as CO_2; electrons also generated by heat or irradiation neutralized the doubly charged metal cations that yielded pure metals. Oxides were formed as an intermediate stage in the production of pure metals; in air, oxides were produced also by oxidation of the pure metal products. The essential difference between electron bombardment and heat lay in the greater carrier-generation efficiency of the former. (OTS)

336 EFFECT OF γ RADIATION ON ADSORPTION PROPERTIES OF SILICA GELS. S. V. Starodubtsev, Sh. A. Ablyaev, E. K. Vasil'eva, and S. E. Ermatov (Inst. of Physics and Tech., Academy of Sciences, USSR). p.689-92 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Factory-made silica gel was heat-treated in evacuated ampoules and then subjected to γ rays at dose rates up to 340000 r/hour. Adsorption was then investigated by admitting a gas or vapor to the ampoules held at temperatures from 20°C to liquid-nitrogen temperature. On cooling, the adsorption ability of silica gel increased even without irradiation, but γ rays intensified the increase. The amount of oxygen adsorbed rose linearly with pressure of the admitted gas or vapor in unirradiated and irradiated silica gel, indicating the same nature of adsorption centers in both cases. The silica gel surface became saturated with adsorption centers at doses of $2-3 \times 10^6$ r. Gamma irradiation raised the amount of heptane vapor that could be adsorbed on silica gel (this effect was smaller than for the majority of gases) but made no difference to the adsorption of benzene vapor. Irradiation of aqueous solutions of ammines of the $[Co(NH_3)_6]Cl_3$ type in direct contact with silica

gel raised the amount of liquid adsorbed because of radio-induced chemical reactions in the solutions rather than due to changes on the silica gel surface. Gamma irradiation also raised the amounts of oxygen and hydrogen that could be adsorbed by aluminosilica gel. (TCO)

337 EFFECT OF PRELIMINARY IRRADIATION ON THE RATE OF THERMAL DECOMPOSITION OF SILVER OXALATE AND CARBONATE CONTAINING ADMIXTURES. V. V. Boldyrev, Yu. A. Zalharov, V. I. Eroshkin, and A. B. Tronov (Tomsk Polytechnic Inst., USSR). p.693-8 of "Trudy II Vsesoyuznogo Soveshchaniya po Radiatsionnoi Khimii." Moscow, Publishing House of the Academy of Sciences, 1962.

Pure Ag_2CO_3, pure $Ag_2C_2O_4$, and the solid solutions 97.5% $Ag_2C_2O_4$ + 2.5% CdC_2O_4, 97.5% Ag_2CO_3 + 2.5% $CdCO_3$, 95% $Ag_2C_2O_4$ + 5% CdC_2O_4 were subjected to γ, x ray, and uv radiations. A study was made of the effects of cadmium on the thermal decomposition after irradiation of the carbonate and oxalate, and the radiolysis of the two compounds. Preliminary irradiation with Co^{60} γ rays (50 C source) or uv radiation accelerated subsequent thermal decomposition of pure oxalate at 158°C but the radiation effect was reduced on addition of Cd. X rays accelerated subsequent thermal decomposition of pure carbonate at 151°C and the acceleration was intensified by adding Cd. Cadmium reduced the photolytic action of γ rays and uv in the case of the oxalate but it intensified the x ray photolysis of the carbonate. The opposite effects of cadmium in the two compounds are due to the difference in the mechanism of decomposition. (TCO)

Separation Processes and Procedures

338 (AE-122) THE PLANNING OF A SMALL PILOT PLANT FOR DEVELOPMENT WORK ON AQUEOUS REPROCESSING OF NUCLEAR FUELS. T. U. Sjoeborg, E. Haeffner, and A. Hultgren (Aktiebolaget Atomenergi, Stockholm). Oct. 1963. 27p.

A shielded volume (42 m^3) in the hot laboratory at Kjeller, Norway, was used for the installation of a small pilot plant intended for studies on nuclear fuel reprocessing. During the first period of operation (1963) a plutonium separation method (the Silex process) developed at AB Atomenergi will be studied. (auth)

339 (ANL-6742) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID BED FLUORIDE VOLATILITY PROCESSES. PART I. THE FLUORINATION OF URANIUM DIOXIDE–PLUTONIUM DIOXIDE SOLID SOLUTIONS. R. L. Jarry, L. J. Anastasia, J. Fischer, L. E. Trevorrow, T. D. Baker, and J. J. Stockbar (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 21p.

Work in the development of fluid-bed fluoride volatility processes is described. In these processes, uranium and plutonium in spent nuclear fuels are converted into hexafluoride compounds in a fluid-bed reactor. The uranium and plutonium hexafluorides are volatile and can be separated from fission products, cladding, and alloying materials by techniques such as vaporization and distillation. The experimental work was directed toward devising a fluorination procedure for uranium and plutonium dioxides which would result in a high degree of removal of uranium and plutonium as hexafluorides. In these experiments synthetic mixtures made up to simulate a charge for a fluidized bed reactor (100 kg U, 0.4 kg Pu, ~1 kg F.P., and 30 kg inert solids) were used. High-purity recrystallized alumina was found to be a suitable material for use as the fluidized inert solid. After a 10-hr fluorination period at 450°C, the concentrations of residual uranium and plutonium on the alumina were 0.01 and 0.03 wt %, respectively. A reaction temperature of 450°C was found to be optimum, since experiments at 500 and 550°C resulted in plutonium retentions on the alumina of 0.060 and 0.090 wt %, respectively. At all these temperatures, the residual uranium content of the residue was less than 0.01 wt %. When fission product element oxides, in quantities that would be expected in a Dresden-type fuel after 100,000 Mwd/ton burnup and 30 days of cooling, were added to the uranium dioxide–plutonium dioxide–alumina and the mixture was fluorinated at 450°C for 10 hr, the concentration of plutonium on the alumina increased to a value of 0.065 wt %. Additional recovery of the plutonium retained on the alumina was obtained by either pyrohydrolysis followed by refluorination at 450°C for 10 hr, or by refluorination alone at 550°C for 10 hr. These procedures reduced the residual plutonium content of the alumina to less than 0.02 wt %. Experiments were also performed to determine the feasibility of using the same batch of alumina as the inert solid for the fluorinations of five batches of the urania–plutonia solid solution. Experiments were performed in which the solid solution of plutonium dioxide in uranium dioxide was oxidized prior to fluorination. The oxidation resulted in a powdered mixture of uranosic oxide and plutonium dioxide. Fluorination of this oxide mixture in alumina resulted in the removal of essentially all of the uranium in a reaction time of 2 hr at 450°C when 10 vol % fluorine was used. When this fluorination was followed by a second fluorination period of 5 hr at 550°C with 75 vol % fluorine, the plutonium content of the alumina was 0.011 wt %. When both fluorination periods were extended to 10 hr each, the retention of plutonium was 0.007 wt %, which corresponded to a removal of 99.5% of the plutonium contained in the solid mixture. During the first part of the fluorination period, in which the major portion of the uranium is removed from the mixture of uranium dioxide, plutonium dioxide, alumina, and representative fission product element oxides, a low temperature (450°C) and a low concentration of fluorine (10 vol % fluorine in nitrogen) are desirable. However, in order to remove the plutonium efficiently during the last portion of the fluorination period, it is desirable to use a higher temperature (550°C) and a higher fluorine content of the gas mixture (75 vol % fluorine in nitrogen). (auth)

340 (ANL-6762) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID BED FLUORIDE VOLATILITY PROCESSES. PART III. SEPARATION OF GASEOUS MIXTURES OF URANIUM HEXAFLUORIDE AND PLUTONIUM HEXAFLUORIDE BY THERMAL DECOMPOSITION. L. Trevorrow, J. Fischer, and J. Riha (Argonne National Lab., Ill.). Aug. 1963. Contract W-31-109-eng-38. 15p.

Experiments were carried out to determine the extent and rate of separation of mixtures of uranium hexafluoride and plutonium hexafluoride by selective thermal decomposition. Gaseous mixtures of uranium hexafluoride, plutonium hexafluoride, and helium were circulated for varying lengths of time through nickel vessels packed with nickel wool at temperatures of 150, 200, and 300°C. The initial ratios of uranium hexafluoride to plutonium hexafluoride in the mixtures were of the order of 10 to 1. The gas phase was analyzed for uranium and plutonium before and after circulation. The amounts of uranium and plutonium in the solid compounds deposited in the vessels were also determined. Passage of the mixtures through the hot vessels resulted in the removal of 99.5 to 99.9% of the pluto-

nium. The solid product remaining in the vessels was plutonium tetrafluoride containing 0.09 to 1.3% uranium. The separation of plutonium hexafluoride from uranium hexafluoride by selective thermal decomposition is applicable to fluid bed fluoride volatility processes for the recovery of fissile material from reactor fuels. (auth)

341 (BM-RI-6322) ACID LEACHING OF BERYLLIUM ORE FROM SPOR MOUNTAIN, UTAH. L. Crocker, R. O. Dannenberg, and D. W. Bridges (Bureau of Mines. Salt Lake City Metallurgy Research Center). Mar. 1963. 19p.

About 95% of the beryllium was dissolved from most ore samples by agitation leaching with 600 lb of H_2SO_4 per ton of ore for 24 hours at 65°C and 35% solids. Leach slurries generally were viscous, and the limiting pulp density for thorough mixing was about 35% solids. Settling of the leached pulp required 0.6 to 0.8 lb of a polyacrylic flocculant per ton of ore leached with 600 lb of H_2SO_4 per ton, whereas ore leached with 800 lb of H_2SO_4 per ton required only 0.2 to 0.3 lb of flocculant per ton. Terminal densities of the settled pulps were about 28 and 35% solids, respectively, from leaches using 600 and 800 lb of H_2SO_4 per ton. Vacuum filtration of settled pulps at 15 in. Hg resulted in a filter cake containing 50 to 59% solids. Roasting the ore at 500°C before leaching increased the limiting pulp density for effective mixing to 50% solids. Acid requirements, however, were not diminished, although leaching roasted ore with 600 lb of H_2SO_4 per ton resulted in densification of settled pulps to about 40% solids. Filter cake from leaching preroasted ore contained about 20% less water than that from unroasted ore. (auth)

342 (CEA-Bib-21) PURIFICATION DU BERYLLIUM (STABILITE DES COMPLEXES EXTRACTION PAR SOLVANTS— ECHANGE D'IONS). (Beryllium Purification (Complex Stability— Solvent Extraction— Ion Exchange)). R. Faroche (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1963. 35p.

This bibliography of 148 references deals with the papers published from 1950 to 1962 inclusive on the purification of beryllium by solvent extraction and ion exchange. The abstracts of the papers are included. (auth)

343 (DP-541) APPLICATION OF AMIDES AS EXTRACTANTS. Thomas H. Siddall, III (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1961. Contract AT(07-2)-1. 14p.

Laboratory data are given and discussed that outline the potential application of N,N-disubstituted amides to the separation of uranium, neptunium, and plutonium from fission products. (auth)

344 (DP-594) PRECIPITATION OF NEPTUNIUM PEROXIDE. Glenn A. Burney and Ernest K. Dukes (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). July 1961. Contract AT(07-2)-1. 14p.

Optimum conditions were determined for the precipitation of neptunium(IV) peroxide from nitric acid solutions. The results indicate that the precipitation could be applied successfully on a plant scale. Data are presented for the solubility of neptunium peroxide in solutions of nitric acid and hydrogen peroxide. The solubility is less than 10^{-4} M in 1.5 to 2.5 M nitric acid containing 4.5 M hydrogen peroxide. Two crystalline modifications of the peroxide were prepared; these two crystalline structures were similar to structures previously reported for plutonium peroxide. (auth)

345 (EUR-426.f) L'EXTRACTION LIQUIDE-LIQUIDE PAR LE CHLORHYDRATE DE TRILAURYLAMINE. (Liquid-Liquid Extraction by Trilaurylamine Hydro-Chloride). G. Duyckaerts, J. Fuger, and W. Mueller (Liège. Universite and Institut Interuniversitaire des Sciences Nucléaires, Brussels). 1963. 152p.

The extraction of several trivalent actinides and lanthanides in tracer amounts by organic solutions of trilaurylamine hydrochloride from concentrated aqueous chloride solutions was investigated. From chemical analysis and physicochemical investigation of the organic phase (titrations of hydrochloric acid and water, infrared absorption, conductivity, cryoscopic, and vapor pressure measurements), it is concluded that trilaurylamine hydrochloride can react with excess hydrochloric acid to form amine dihydrochloride. The amine salt exists partially in an associated form; its hydration depends on the water activity of the aqueous phase. The extraction of ferric chloride which was undertaken for comparison showed the formation of two ferric complexes in the organic phase; these complexes contain amine salt and ferric chloride in a molar ratio of 2:1 for small concentrations, in a 1:1 ratio for high iron concentrations. The extraction of iron from dilute or concentrated acid solutions is accompanied by a decrease of the water content or the excess acid in the organic phase; the extracted metal exists as tetrachloroferrate. The extraction coefficients of actinides increase with the second power of amine salt concentration in the organic phase which means that the complex contains two molecules of amine per metal atom. The decrease of the extraction coefficient with the aqueous phase acidity may be explained by assuming two competing reactions with the amine: metal complex and the dihydrochloride formation. Actinide extraction decreases with temperature. The order of extractibility is: Cf > E ≫ Am > Cm ≫ Sc ≫ lanthanides. (auth)

346 (NAA-SR-Memo-8857) REMOVAL OF FISSION PRODUCTS AND PLUTONIUM IN REPROCESSING AND REFABRICATION OF UC FUEL. W. G. Smiley (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 9, 1963. Contract AT(11-1)-Gen-8. 7p.

UO_2–carbon pellets with three C:UO_2 ratios were prepared from irradiated UO_2 containing 35 ppm of plutonium, and converted to UC by heating in vacuum in a graphite crucible, with maximum temperatures of 1560, 1760, and 1940°C. Plutonium loss was as high as 46%, and up to 98% on arc melting. Cerium loss was similar to plutonium, suggesting that plutonium behavior could be predicted from that of cerium in fissia mixtures. Arc melting of irradiated UC also produced substantial plutonium losses. It is concluded that arc casting probably cannot be used for refabricating pyroprocessed UC (or for initial fabrication of UC–PuC fuel). (auth)

347 THE SOLVENT EXTRACTION OF THE THIOCYANATE COMPLEXES OF TITANIUM, NIOBIUM, AND TANTALUM. PART I. GENERAL STUDY OF VARIABLES. Eduardo A. Mari (Universidad, Buenos Aires). Anal. Chim. Acta, 29: 303-11(Oct. 1963).

The solvent extraction of titanium, niobium, and tantalum thiocyanates was studied in detail. The effect of the variables (solvent, concentration of thiocyanate, and acidity) is discussed. There is evidence for the existence of a thiocyanate complex of tantalum. (auth)

348 THE SOLVENT EXTRACTION OF THE THIOCYANATE COMPLEXES OF TITANIUM, NIOBIUM AND TANTALUM. PART II. APPLICATION TO THE SEPARATION OF MIXTURES. Eduardo A. Mari (Universidad, Buenos Aires). Anal. Chim. Acta, 29: 312-20(Oct. 1963).

Solvent extraction of the thiocyanate complexes of titanium, niobium, and tantalum allows the separation of micro quantities of the elements. Niobium and tantalum are separated by selective extraction of the fluoro-complexes. Mixtures of Ti and Nb, or of Ti and Ta in ratios of 500 : 1 to 1 : 500 can be separated. For mixtures of the three elements, results were acceptable with Nb : Ta ratios of 100 : 1 to 1 : 100. Colorimetric determinations of the three elements are described. (auth)

349 THE REMOVAL OF Ce, Nd, Pr AND La FROM Er, Dy, Gd, Eu AND Sm BY ANION EXCHANGE. R. A. Edge (Univ. of Cape Town). Anal. Chim. Acta, 29: 321-4 (Oct. 1963).

An anion-exchange procedure with 35% 3.5 N nitric acid–65% methanol as eluant was developed for the removal of Ce, Nd, Pr, and La from Er, Dy, Gd, Eu, and Sm, at the trace concentration level. (auth)

350 COUNTER-CURRENT LIQUID-LIQUID EXTRACTION IN ROTARY ANNULUS COLUMNS. R. Spence and R. J. W. Streeton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem. Process Eng., 44: 597-610 (Oct. 1963).

The mechanism of operation and utility of a rotary extractor for the extraction of uranium was investigated. The rate of transfer of uranyl nitrate across the interface between drops and continuous phase in the dibutoxy diethyl ether/aqueous system was found to depend on the transport of the solvated uranyl nitrate molecule through a solvent film at the interface. The rate of transfer in the case of a single drop in the rotary column is only about twice that found for a drop falling freely through a static continuous phase. (P.C.H.)

351 A DIFFERENTIAL STAGE CASCADE DESIGN FOR SEPARATION OF TWO COMPONENTS IN A DILUTE SOLVENT. Gerald T. Fisher and John W. Prados (Univ. of Tennessee, Knoxville). Ind. Eng. Chem. Fundamentals, 2: 300-4(Nov. 1963).

The equations of a differential stage cascade for the separation of two components that are in a dilute solution with a third component, a solvent, are formulated. The equations were developed for the thermal diffusion separation by horizontal columns (Jury-Von Halle type) of two salts in water solution, but they will apply to any system that can be characterized by a constant mass transfer coefficient and a linear equilibrium relation. A specific solution is presented for a thermal diffusion cascade separating $CuSO_4$ from $CoSO_4$ in H_2O. (P.C.H.)

352 TYPES OF ACIDIC ORGANOPHOSPHORUS EXTRACTANTS AND THEIR APPLICATIONS TO TRANSURANIC SEPARATIONS. G. W. Mason and D. F. Peppard (Argonne National Lab., Ill.). Nucl. Sci. Eng., 17: 247-51 (Oct. 1963).

Certain applications of acidic organophosphorus extractants to transuranic separations are described. In a system employing mono-2-ethyl hexyl phosphoric acid, (2-EtHexO) $PO(OH)_2$, symbolized as H_2MEHP, in toluene vs a concentrated aqueous NH_4CNS solution, the ratio K_{Pm}/K_{Am} is approximately 50, while in the corresponding TBP system it is considerably less than unity. The H_2MEHP (in toluene) vs HCl system was used in effecting mutual M(III), M(IV), and M(VI) separations. Throughout the 1-12M HCl range the extractant dependency (0.05-0.3F H_2MEHP) approximates first power for lanthanides(III), Pu(III), Am(III), Np(IV), and U(VI). Comparable studies of other H_2MGP and H_2[GP] compounds, i.e., $(GO)PO(OH)_2$ and $GPO(OH)_2$, are reported. A system employing HDΦP, i.e., $(C_6H_5O)_2PO(OH)$, in toluene vs a concentrated aqueous chloride phase serves to effect the difficult Cf-Y separation, the ratio K_{Cf}/K_Y being approximately 400. Systems involving a mono acidic phosphate, HDGP, or phosphonate, HG[G'P], in a diluent vs an aqueous mineral acid solution proved valuable in effecting the Cf–Cm separation, Cf extracting the better. The fact that actinides(IV) are much more extractable than actinides(III) in HDGP vs mineral acid systems is utilized in the purification of Bk(IV) by extraction from a nitrate solution into a n-heptane solution of di 2-ethyl hexyl-phosphoric acid, HDEHP. (auth)

353 APPLICATION OF AMINE AND PHOSPHONATE EXTRACTANTS TO TRANSPLUTONIUM ELEMENT PRODUCTION. R. E. Leuze, R. D. Baybarz, and Boyd Weaver (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 252-8(Oct. 1963).

The Tramex process, in which trivalent actinides are extracted into tertiary amine hydrochloride from concentrated lithium chloride solution, was developed for isolation of transplutonium elements from irradiated High Flux Isotope Reactor targets. Tests made in laboratory scale mixer-settlers gave americium losses of about 0.01% and fission product decontamination factors of equal to or greater than 10^4. Nickel was the only contaminant that followed the transplutonium elements through the Tramex process. No serious radiation induced effects were noted in 1- to 10-ml batch extraction tests at activity levels up to the proposed processing level of 10 w/liter. A process was developed for splitting transplutonium elements into two fractions. Transcurium elements are extracted into mono-2-ethyl-hexyl phenyl phosphonic acid from dilute hydrochloric acid while americium-curium and nickel contaminant from the Tramex process remain in the aqueous phase. Demonstration in a 10-ml batch countercurrent extraction with simulated feed containing tracers gave a californium loss of about 0.1% and an americium decontamination factor of 10^3. Important variables for both extraction processes are discussed. (auth)

354 SOLVENT EXTRACTION, RECOVERY, AND PURIFICATION OF BERYLLIUM FROM ORES. R. A. Wells, D. A. Everest, and A. A. North (National Chemical Lab., Teddington, Middx, Eng.). Nucl. Sci. Eng., 17: 259-67(Oct. 1963).

An investigation was made of the selective solvent extraction of beryllium from sulfate liquors by means of esters of orthophosphoric acid. The sulfate liquors were obtained from the treatment of beryl flotation concentrates. The preferred extractant is di-(2-ethylhexyl) phosphoric acid dissolved in kerosene. Tests with this solvent provided design data for the forward-extraction and solvent-stripping processes. Tests with actual leach liquors showed that high-grade products were obtained by the procedures described. (auth)

355 PURIFICATION OF BERYLLIUM BY ACETYLACETONE–EDTA SOLVENT EXTRACTION. R. E. Moore, J. H. Shaffer, C. F. Baes, Jr., H. F. McDuffie, and C. E. L. Bamberger (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 268-73(Oct. 1963).

A solvent extraction process for the purification of beryllium was described previously in which ethylenediamine tetraacetic acid (EDTA) is used as a masking or sequestering agent to retain metallic impurities in an aqueous phase from which the beryllium is extracted into an organic phase (CCl_4) as a complex with acetylacetone (HX). Subsequent back extraction of the beryllium into nitric acid, followed by the precipitation of beryllium hydroxide, filtering, drying, and calcination to 1000°C, gave BeO products of

high purity. Approximately 1300 gm of BeO were prepared in 23 batches. The average impurity content of these batches (based on BeO) was very low — less than 10 ppm each of Ca, Al, and Si; less than 5 ppm each of Fe, Mg, and Cu; all other metallic impurities were below the level of detection by the spectrographic method of analysis. The maximum impurity contents for individual metallic species among all these batches were, in ppm BeO, Al–9, Ca–10, Cu–13, Mg–5, Fe–10, Si–11; these are considered to reflect the difficulty of keeping small batches free from contamination by dusty air and should not occur in larger operations. A quantitative treatment of the extraction equilibria and masking equilibria involved in the process was undertaken. Spectrophotometric analytic techniques recently applied to the simultaneous determination of acetylacetone and its beryllium complex greatly facilitated this study; radioactive beryllium-7 was used as a tracer to make possible the rapid determination of distribution coefficients. The results were generally as expected; the formation constants for the mono- and di-acetylacetonates of beryllium were calculated (at I = 0.10). Anomalously high distribution coefficients were noted under conditions associated with the presence of high concentrations of NaCl, and even the disodium salt of EDTA, in the aqueous phase. The significance of the anomalous conditions is discussed in terms of water activity and the degree of hydration of the acetylacetone complex of beryllium. (auth)

356 AMINES AS EXTRACTANTS. C. F. Coleman (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 274-86(Oct. 1963).

Both study and use of extractions with high molecular weight amines (including quaternary ammoniums) in organic solution are increasing extensively. While equilibria were measured in extraction of an increasing range of acids and metal ions, a difficulty remains unresolved in that the amine concentration power-dependence of extraction often indicates a different complex stoichiometry than do limiting loading and other considerations. Nevertheless, amine extraction serves as a useful tool in studying aqueous complex systems. Process applications progressed especially in nitrate and chloride systems, in addition to the sulfate systems first emphasized. Systematic surveys together with information accruing from process development extended the ranges of extractions that can be correlated in usefully generalized patterns, which in turn should accelerate the development of new applications. However, many more areas remain to be surveyed before the many pertinent variables are covered. New amines of all classes have become available at commercial, development, or research-sample levels, while a few previously promising amines have become less available. Descriptions and current sources are reviewed. (auth)

357 ION-EXCHANGE SORPTION OF URANIUM ON PEATS FROM DILUTE SOLUTIONS. Kazimierz Majchrzak (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 225-31(1963

The practicability of sorption of uranium from solutions of the concentrations of 1 g/l and 1 mg/l on peat was investigated. The exchange capacity of peat was found to depend on the pH of the solution and on the complexing of the uranyl cation. Sorption maximum is at pH 4—5. Complexing ions depress markedly the exchange capacity of peat. Sorption of uranium from mine waters on peat was found to be practicable. When mine water, acidified to pH 4.5 is passed through peat its uranium concentration falls below 0.01 mg/l. Hydraulic resistance of peat was minimized by the use of horizontal-flow exchange apparatus. (auth)

358 SEPARATION OF PROTACTINUM FROM THORIUM BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Irena Fidelis, Rajmund Gwozdz, and Slawomir Siekierski. Nukleonika, 8: 245-8(1963). (In Russian)

The reversed phase partition chromatography method was applied for the separation of protactinum from thorium. The protactinium was found to be strongly held on the column whereas thorium was easily eluted with HCl. Protactinium could be then eluted with 5% oxalic acid. (auth)

359 THE SEPARATION OF ARSENIC FROM GERMANIUM BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Irena Fidelis, Rajmund Gwozdz, and Slawomir Siekierski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 319-26(1963).

Reversed-phase partition chromatography was applied for the separation of microamounts of arsenic from macroamounts of germanium. The availability of the method was proved for separation of carrier-free As^{77} from germanium target. The separation of two oxidation states of arsenic was performed. (auth)

360 SEPARATION OF CARRIER-FREE ^{199}Au FROM PLATINUM BY REVERSED-PHASE PARTITION CHROMATOGRAPHY. Irena Fidelis, Rajmund Gwozdz, and Slawomir Siekierski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 327-31(1963). (In Russian)

The method of reversed-phase partition chromatography with TBP as immobile phase was applied to separate the carrier-free gold from a platinum target. The possibility of concentration of tracer solutions on chromatographic column was proved. (auth)

361 ANION-EXCHANGE SEPARATION OF RARE EARTH ELEMENTS AND THORIUM FROM URANIUM WITH CARBONATE SOLUTIONS. Tomitsugu Taketatsu (Kyushu Univ., Fukuoka). Talanta, 10: 1077-82(Oct. 1963).

Quantitative separation of some rare earth elements and thorium from uranium(VI) was carried out using Dowex 1, X-8 with 0.7M potassium carbonate or 0.4M ammonium carbonate solution as eluant. The procedure may also be used to separate micro amounts, especially trace amounts, of rare earths in uranium fission products. (P.C.H.)

362 NIOBIUM EXTRACTION WITH TRIBUTYLPHOSPHATE (TBP). G. P. Giganov and V. D. Ponomarev. Tr. Inst. Met. i Obogashch., Acad. Nauk Kaz. SSR, 5: 119-24(1962).

Graphoanalytical and physico-chemical methods of measuring the electric conductivity of the organic phase were employed to investigate complex formation in systems $HF-Nb_2O_5-TBP$ and $HF-H_2SO_4-Nb_2O_5-TBP$. Niobium extraction was studied as a function of hydrofluoric acid concentration, metal concentration in the solution, and tributylphosphate concentration in the extractant. At relatively low Nb concentrations in the initial solution the composition of the complex to be extracted was determined in three series of experiments using solutions with different concentrations of hydrofluoric and sulfuric acids and equal Nb content. It was established that in the presence of 3 mole sulfuric acid in the aqueous solution, the extremal niobium concentration in undiluted tributylphosphate is 1 mole/l or 133 g/l Nb_2O_5. In the absence of sulfuric acid in the aqueous solution, the extremal Nb content in the extractant can only attain 0.74 mole (98 g/l Nb_2O_5). Out of hydrofluoric acid solutions, with and without sulfuric acid, niobium is extracted with tributylphosphate in the form of a trisolvate ($HNbF_6 \cdot 3TBP$). From niobium-saturated solutions with a solid phase, niobium is trans-

ferred to the ester phase in the form of oxyfluoride complexes $H_2NbOF_5 \cdot 3TBP$, $HNbOF_4 \cdot 3TBP$. (OTS)

363 EFFECTS OF FLUORINE COMPLEXES ON ZIRCONIUM SEPARATION BY TRIBUTYLPHOSPHATE. V. M. Kolikov and V. N. Rybchin. Zh. Prikl. Khim., 36: 1410-15(July 1963). (In Russian)

Effects of fluorine content on zirconium extraction from potassium fluozirconate by tributylphosphate were analyzed. Precipitation of zirconium from K_2ZrF_6 solution separates the crystalline compound ZrO(OH)F; dissolution of precipitate in nitric acid liberates fluorine. Fluorine ions effect Zr polymer and molecular forms and results in partial replacement of NO_3^- by F. (R.V.J.)

364 CARMEN CHEMISTRY FACILITY FOR REPROCESSING IRRADIATED FUELS IN GAS-TIGHT SHIELDED ENCLOSURES. Pierre Faugeras, Jean-Claude Boudry, Guy Lefort, Colette Lheureux, and Jean Stratakis (Commissariat à l'Énergie Atomique, Paris). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 89-111(1963).

The "CARMEN" series of cells is an α-β-γ facility in operation at Fontenay-aux-Roses. This facility was conceived at the end of 1959 to study the chemical reprocessing of irradiated fuels on a laboratory scale, and more precisely, solvent extraction. This series of cells was developed in order to handle about 10 curies in each cell. Each working station is a glove box protected by 15 cm of steel for shielding. All the apertures, including the introduction lock, are closed with removable γ-shielded doors and a leak proof system generally obtained by use of a vinyl chloride bag. The work on the chemical apparatus inside the box is carried out using Model 7 Manipulators installed in such a way as to prevent leakage around the vinyl chloride sleeve. All the servomechanisms of the line are outside the facility except the hydraulic cylinders operating some of the movable shielding. The cells are used for the dissolution of irradiated fuels, for the separation of the uranium from the plutonium and fission products, and for the study of the decontamination of new processes. On the other hand, it is possible to carry out different analyses in one cell with complete safety. Further, the samples are transferred from one box to another, without direct handling. (auth)

365 IN-CELL ALPHA ENCLOSURE FOR DISASSEMBLY AND EXAMINATION OF PLUTONIUM-ENRICHED FUEL-ELEMENT CAPSULES. J. E. Corrigan and R. F. Stearns (General Electric Co., Pleasanton, Calif.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 245-54(1963).

An alpha enclosure for the disassembly and examination of plutonium-enriched fuel capsules is in operation in one of the Radioactive Materials Laboratory megacurie cells of the Vallecitos Atomic Laboratory. To safely handle the irradiated PuO_2-UO_2 fuels with less than 50,000 MWD/T burnup, an enclosure is used for plutonium containment with the cell walls providing the required shielding. The enclosure provides facilities for capsule opening, Na and/or NaK reaction within the capsule body, fuel pin photography, diameter and profile measurements, gamma scanning, vacuum potting, and fuel sectioning. Metallographic equipment for sample mounting, grinding, polishing, and examination at 50 and 100× magnifications is also available. Operating experience showed that the enclosure allows flexible operations, and is effective in containment of contaminants. No increase in contamination was detected within the cell since operations were started. (auth)

366 HA COLUMN, T-H2 (Engineering Materials). (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (CAPE-1056)

This package contains 3 drawings. The HA column is used for liquid-liquid extraction. The lower half of the column is used for extraction and the top half of the column is used for scrubbing. Mixing of the two immiscible phases is accomplished in the round column sections by using a pulsing mechanism, which moves the liquid through the sieve plates. The top and bottom sections are used for phase disengaging. (F.S.)

ENGINEERING

General

367 (AEDC-TDR-63-154) LUBRICATION REQUIREMENTS FOR SPACE ENVIRONMENTS. J. D. Pinson and W. F. McRae (Arnold Engineering Development Center, Tullahoma, Tenn.). Oct. 1963. 43p.

A concise review is presented of present work being undertaken by leading scientists throughout the country in development of space lubrication. A detailed description of research undertaken by the Arnold Engineering Development Center in this area is also presented with special emphasis on results of tests related to operating gears and bearings in a simulated space environment. (auth)

368 (TID-4100(1st Rev., Suppl.18)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Richard E. C. Duthie, ed. (Division of Technical Information Extension, AEC). Aug. 1963. 162p.

Included are lists under computers, engineering equipment (miscellaneous), hot laboratory equipment, hot laboratory structures, instruments, metallurgical equipment and processes, nuclear radiation instruments, nuclear reactors and reactor facilities, particle accelerators, plant design and processes (chemical), radiation equipment (biological), radiation source units, shielded containers, thermonuclear devices, and waste disposal equipment. (P.C.H.)

369 AN ELASTIC-PLASTIC CYLINDER WITH FREE ENDS AND INTERNAL HEAT GENERATION. William A. Beyer (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 17: 179-84(Oct. 1963).

The elastic-plastic deformation of a long cylinder subjected to uniform heat generation Q is considered using Tresca's yield function and an associated flow rule for perfectly plastic material. The ends of the cylinder are assumed to be free and all elastic and thermal parameters temperature-independent. It is supposed that the outer surface is insulated and that heat is removed from the inner surface. If Q is allowed to increase at a sufficiently slow rate so that time effects can be neglected, then yielding commences on the inner surface. For the Poisson ratio $\nu = 0.3$, immediately after initiation of yield two inner plastic regions and an elastic region form. One of the plastic regions corresponds to a singular regime of the Tresca yield function. The interfaces of the regions propagate outward as Q is increased. For outer to inner cylinder radius ratio equal to 5 it was found that, for Q about 4 times the value giving the initial plastic yielding, a third plastic region formed in the interior of the elastic region. The equations involved were solved numerically. (auth)

Applications of Nuclear Explosions

370 (AD-297052) PEACEFUL USES OF NUCLEAR EXPLOSIVES. Wilbur C. Buckheit (Defense Atomic Support Agency. Field Command, Albuquerque, N. Mex.). Sept. 1, 1962. 27p. (Project PLOWSHARE.

A summary is presented of the activities in the PLOWSHARE program, which includes excavation, recovery of power and isotopes, and water resources and mining. Information is given on the size and charge for nuclear detonations for peaceful uses. A bibliography is included. (D.L.C.)

371 (NP-13279) OPERATION PRE-DRIBBLE. SEISMIC EFFECTS OF 1000 LB H-E DETONATIONS IN SALT AND SEDIMENTARY DEPOSITS. W. V. Mickey (Coast and Geodetic Survey, Washington, D. C.). Aug. 1963. 41p.

A high-explosive detonation program was conducted in the DRIBBLE area from April to June 1963. Several shots were detonated on or near the Tatum Salt Dome. Tables and plots of seismic data are given for the 1000-lb shots in the sedimentary deposits and salt. The COWBOY 1000-lb shots in salt are included for reference. (D.L.C.)

372 (PNE-304) PROJECT PRE-BUGGY. BASE SURGE ANALYSIS. Final Report. J. B. Knox and R. Rohrer (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1963. Contract W-7405-eng-48. 37p.

The data concerning the base surge cloud radius and base surge cloud height as a function of time for the Pre-Buggy series of high explosive shots are summarized. An analysis of this information from the Pre-Buggy sequence yields empirical relationships between the maximum base surge radius (cross wind) and the degree of atmospheric instability, and the maximum base surge radius (cross wind) in a neutral atmosphere and the scaled depth of the explosive in an alluvium medium. (auth)

Facilities and Equipment

373 (CONF-251-1) PERFORMANCE CHARACTERISTICS OF A PERIPHERAL COMPRESSOR. P. S. Cates (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1962]. Contract [W-7405-eng-26]. 30p.

From Rotating Machinery for Gas Cooled Reactor Application, Gatlinburg, Tenn., Nov. 1963.

The merits of peripheral and centrifugal compressors are compared. A study was made of the performance characteristics of a peripheral compressor with a 10-inch diameter impeller. Runs were made at 5000 to 14,000 rpm on gases of molecular weight from 4 to 400, and the performance parameters are reported in dimensionless form. The results for helium are compared with data for other peripheral compressors. The effects of channel geometry and impeller-to-casing clearances on the performance were also studied. (D.L.C.)

374 (HW-77912) THE EFFECT OF HOLES ON THE PERFORMANCE CHARACTERISTICS OF HIGH-EFFICIENCY FILTERS. F. E. Adley and D. E. Anderson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Sept. 25, 1963]. Contract AT (45-1)-1350. 11p. (CONF-255-2)

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

An investigation was made on how damage to high-efficiency filters affects their efficiency. A simple filter paper experiment demonstrated that the presence of a hole changes the airflow-pressure drop relationship. After the addition of holes to commercial space filters, the penetration was found to change from a direct relation with airflow to an inverse relation. Studies were made of 19 space filters, 7 of which had "as found" defects; an

empirical estimation was made of the size of the defects, and a correlation was developed between the penetration and equivalent hole area. It is concluded that the integrity of a high-efficiency filter can be tested by whether its penetration increases or decreases with airflow. (D.L.C.)

375 (NP-13245) QUARTERMASTER RADIATION LABORATORY, NATICK, MASSACHUSETTS. PART I. GENERAL DESCRIPTION AND SITE CHARACTERISTICS. PART II. TECHNICAL DESCRIPTION OF FACILITY. (Quartermaster Research and Engineering Command, Natick, Mass.). Aug. 1961. 178p.

The proposed Natick laboratory is to be used for research and development of irradiation preservation of foods. The laboratory will include a megacurie Co^{60} cell, a 24-Mev linear accelerator, nuclear control laboratories, a pilot plant area for food preparation, etc. A detailed description is given of the radiation laboratory, facilities, site location, and environmental characteristics. (D.L.C.)

376 (TID-4100(1st Rev., Suppl. 19)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Richard E. C. Duthie, ed. (Division of Technical Information Extension, AEC). Oct. 1963. 116p.

Included are lists under hot laboratory equipment, hot laboratory structures, instruments, metallurgical equipment and processes, nuclear radiation instruments, nuclear reactors and reactor facilities, particle accelerators, plant design and processes, radiation source units, rockets and missiles, shielded containers, and waste disposal equipment. (D.L.C.)

377 (TID-19549) THE APPLICATION OF GAS-LUBRICATED BEARINGS TO HIGH-SPEED TURBO MACHINERY. Quarterly Technical Report, June 1, 1963–August 31, 1963. E. J. Gunter, Jr., J. G. Hinkle, and D. D. Fuller (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract AT(30-1)-2512. 57p. (Q-A2392-3-10)

Effort is applied to the design and analysis of both self-acting and externally-pressurized gas-lubricated bearings. The steady state characteristics of the self-acting, pivoted-pad, gas-lubricated bearing are discussed. A general discussion of the effects of the lubricant compressibility on bearing performance is presented. A series of computer field plots of film thickness for a partial journal bearing for various values of the compressibility parameter Λ are given. Analysis of the shoe friction characteristics is made. Correlation of the experimental and theoretical relationship between shoe load carrying capacity and hydrodynamic pivot pressure is accomplished. (N.W.R.)

378 (EURAEC-440) TESTS ON MORTARS. Special Report No. 1. (Ghent. Rijksuniversiteit). July 19, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 002-61-12-DIV B. 25p. (A translation).

Cyclic tests were carried out on mortars of the Freyssinet type which are to be used in a 6000-ton traction machine. The tests consisted of raising the pressure from zero to a value at which the mortar exerts the desired force, increasing the pressure slightly to expand the mortar 15 mm, and then compressing the mortar back to its original thickness. (D.L.C.)

379 (EURAEC-737) DESIGN, CONSTRUCTION AND FINALIZATION OF A CONTINUOUS INDUSTRIAL FURNACE FOR SINTERING IN CRACKED AMMONIA. B. Aubry (Compagnie Generale de Telegraphie sans Fil, Paris); and R. Lepers (Compagnie Industrielle des Combustibles Atomiques Frittes, Corbeville, par Orsay (Seine-et-Oise), France). 1963. Work Performed under United States–Euratom Joint Research and Development Program. 45p. (A translation)

A design study was carried out on a continuous industrial furnace for sintering uranium oxide in a reducing atmosphere. The furnace was to have flexible temperature control and control of the rate of feed, a substantial production of the order of 4 tons a month, and perfect reproducibility of the sintering results with regard to the dimensions, density, structure, and chemical composition of the sintered pieces. After investigation of the various possibilities it was decided to construct a fully automatic pusher type furnace containing a binder removal zone. The rated sintering temperature is 1650°C with possible peaks of up to 1700°C. The main furnace operates in cracked ammonia and the binder removal furnace in cracked ammonia burned at 800°C. The pieces for sintering are supported by molybdenum boats selected for their robust properties. The sole and the entire brickwork for temperatures of up to 1000°C are made of very pure alumina, and the remainder of the brickwork of silica and alumina. The heating elements are made of tungsten in the firing zone and of molybdenum in the preheating zone. After the mechanical parts had been tested cold the furnace operated satisfactorily for about two months and sintered several hundred kilograms of UO_2 pellets. (auth)

380 SAFETY IN GLOVE-BOX DESIGN AND OPERATION. L. N. Howell. p.87-94 of "Nuclear Safety. Vol. 5, No. 1."

Glove-box design considerations are discussed. Procedures and practices in glove-box operation are described. The prevention and control of fires and explosions in glove boxes are discussed. (M.C.G.)

381 PROCEEDINGS OF THE ELEVENTH CONFERENCE ON HOT LABORATORIES AND EQUIPMENT. Held in Conjunction with American Nuclear Society Winter Meeting, New York, N. Y., November 18-21, 1963. (American Nuclear Society, Hinsdale, Ill.). 84p. $10.00(ANS) (CONF-187)

Proceedings of the Eleventh Conference on Hot Laboratories and Equipment are presented. Separate abstracts are presented for 31 papers. Nine papers were previously abstracted for NSA. For these nine papers, see abstracts 17-35936, 17-36872, 17-36874, 17-35956, 17-35957, 17-35998, 17-21807, 17-21808, and 17-40987. (M.C.G.)

For abstracts of individual papers see: 195, 364, 365, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 472, 473, 512, 589, 590, 639, 640, 641, 673, 674, 675, 676, 677, 1276, 1290, 1310, and 1316.

382 DESIGN AND CONSTRUCTION OF ORNL HIGH-RADIATION-LEVEL ANALYTICAL LABORATORY. L. T. Corbin, W. R. Winsbro, C. E. Lamb, and M. T. Kelley (Oak Ridge National Lab., Tenn.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 3-10(1963).

The high-radiation-level analytical laboratory was designed and built for use in the chemical analysis of highly radioactive materials. The in-line hot-cell bank has separate cells for unloading, storing, performing analyses (six cells), and nondestructive testing. Supporting areas include laboratories and rooms for assemblying equipment, decontaminating equipment, and changing clothes. The salient features are an intercell conveyor, transfer drawer, maintenance cart, cask-transfer cart and interchangeable work pans. All areas in which radioactive operations are performed and which are adjacent to these operating areas

are equipped for the safe handling and confinement of radioactive materials. (auth)

383 LECA—IRRADIATED FUEL STUDY LABORATORY. C. Brebant, H. Dick, A. Junca, A. Portal, and P. Wallet (Cadarache Nuclear Research Center, France). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 17-32 (1963).

The design of the irradiated fuel study laboratory (LECA) at CADARACHE was based on the design of laboratories at the SACLAY Nuclear Research Center. The process cells in this laboratory are designed for machining of samples and the handling of complete irradiated fuel elements with supporting physical and metallographic work on small amounts. (M.C.G.)

384 DESIGN CONSIDERATIONS FOR UNIVERSITY-SIZE HOT CELL FACILITIES. A UNIVERSITY OF CHICAGO RADIOCHEMISTRY LABORATORY. V. Herrero Climent and Jerry M. Watson (Univ. of Chicago). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 113-38(1963).

A practical procedure for shielding estimates and a body of data on shielding design, selection of components and economics, as applied to "1 to 1000 curie" hot cell laboratories, is presented. Available information based on a review of the literature, supplemented with data obtained from industrial references, is analyzed and applied to discuss step by step the designing of a small, modern, versatile laboratory. A brief error-analysis of shielding parameters is included, and standards suggested for uniform cell rating. The linear absorption coefficient and "infinite wall" dose buildup factors of ferrophosphorus concrete for Co^{60} were measured by a gamma-spectrometry method, and the latter compared with values calculated for point and plane sources. (auth)

385 MASTER-SLAVE MANIPULATOR MODEL THROUGH THE CEILING WITH INDEX MOTION AND ALPHA-BETA-GAMMA SHIELDING. Jean Vertut (Commissariat à l'Énergie Atomique, Saclay, France), Guy Lafort, Joseph Rouillard, and Jean-Pierre Cazalis. Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 191-6(1963).

A master-slave manipulator, which works in high activity enclosures, is described. Through-the-ceiling operation of this manipulator permits the use of much smaller viewing ports than previously possible and provides improved shielding on the ceiling. This manipulator is suitable for work involving alpha, beta, and gamma radiation. Its design incorporates types of hermetic seals that can be replaced without interfering with the vacuum inside the cell. A special device enables the operator to make such a replacement without irradiation risks. (auth)

386 TRANSPORT SYSTEM IN ARGONNE CHEMISTRY CAVE. C. H. Youngquist, D. J. Lind, G. A. Mack, W. C. Mohr, and J. A. Van Loon (Argonne National Lab., Ill.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 267-79(1963).

The Argonne Chemistry Cave is laid out with a rail system that connects the individual cells with the central radiation lock corridor as well as a loading dock. A 20 ton capacity rail car carries large shipping casks from the loading dock to the interior of the cave for unloading. A radio controlled flat car traverses the narrow gauge rail system throughout the cave and obeys up to eight commands sent from a small radio transmitter. The transmitter plugs into the cave antenna system at various shielding windows. Remotely operated turntables enable the car to make right angle turns into the cells. A remotely operated elevator whose tracks line up with rails in the floor carries the flat car between the two cave floors and a storage area on the third floor. (auth)

387 FIXED AUTOMATIC AND MANUAL SYSTEM TO CONTROL FIRES. John P. Hughes, Thomas E. Franck, and Fred J. Schmitz (Argonne National Lab., Ill.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 285-94(1963).

A method of extinguishing fires in glove boxes and hoods with carbon dioxide either automatically or manually before absolute filters could be clogged presents a safety feature for the chemist in plutonium-research laboratories. The automatic carbon dioxide release is electrically controlled through a rate-compensated electric heat detector that reacts to a temperature of 160°F. The heat detector releases electrically the carbon dioxide to a sealed nozzle where gaseous carbon dioxide forms as it flows through an orifice to completely fill the enclosure 15 seconds after discharge and continually flows for a minimum of 2 minutes. The liquid carbon dioxide discharged activates a pressure sensitive switch; this notifies the Fire Protection Department, sounds an alarm bell, and lights a neon lamp at the enclosure annunciator box. (auth)

388 A SIMPLIFIED PROCEDURE FOR ALTERATION AND MAINTENANCE OF PLUTONIUM GLOVEBOXES. H. V. Rhude and L. R. Kelman (Argonne National Lab., Ill.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 347-51(1963).

A portable housing was developed which greatly simplifies plutonium glovebox alterations or maintenance which might release contamination. With this housing alterations and maintenance can be done in the laboratory where the glovebox is used, without hindering research in adjacent gloveboxes. The housing is essentially a very shallow glovebox that can be moved up to another glovebox and attached to it by means of tape and a plastic transition piece. Although originally developed to change a broken window, the housing was adapted to other maintenance jobs. With the techniques developed for its use, the housing was used to introduce or remove equipment through a window opening, to service contaminated equipment attached to a glovebox, to repair or alter contaminated pipes and ducts, and to prepare contaminated gloveboxes for moving from one building to another. (auth)

389 NEW INTERCHANGEABLE SEALS FOR PORTS IN ALPHA-BETA-GAMMA CELLS. G. Lefort (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France); J. Vertut, and Jean-Pierre Cazalis. Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 353-60(1963).

Hermetic seals on cells and enclosures containing radioactive materials can be made with the aid of a double-action flexible lip joint, which is only connected to the inner enclosure so that the outer shielding can be removed without interfering with the air-tight system. The hermetic seal incorporates rigid, semi-rigid, and flexible components which interact in such a way that the protective attachment in the interior of the cell can be exchanged without breaking the seal. The exchange of a glove is described in detail. For the connection of two α-β-γ cells, or for their subsequent separation, a triple-action lip joint system is used. Here again the closed system is only established between the two α-enclosures. (auth)

390 PROBLEMS ASSOCIATED WITH THE USE OF INFLATABLE SEALS FOR ENCLOSURES CONTAINING HIGH-PURITY ATMOSPHERES. D. P. Mingesz and D. E. Czernik (Argonne National Lab., Ill.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 361-8(1963).

Several problems are directly associated with the use

of inflatable seals in high-purity atmosphere applications. Some of these were overcome during the design and testing of seal doors for a large transfer lock in an alpha-gamma research cave. However, it was only after experimentation with different seals and retaining methods that the inflatable seals were made to function adequately. Two seals, with a nitrogen pressurized annulus between them, are used on each of the doors. Therefore, any leakage through the seals occurs from the annulus outward and prevents the air atmosphere on one side of the door from polluting the nitrogen atmosphere on the other side. Without this arrangement, the leak rate through the inflatable seals would be too high. (auth)

391 ROUND TABLE DISCUSSION ON OPERATING EXPERIENCE. Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 455-62(1963).

Hot-cell operations at Brookhaven National Laboratory, Knolls Atomic Power Laboratory, Los Alamos power reactor and Rover hot-cell facility, Atomics International, Argonne National Laboratory physical and metallurgical hot laboratory, and Vallecities Atomic Laboratory are discussed. (M.C.G.)

392 THE ESTIMATION OF GAMMA-RAY SHIELDING FOR HOT CELLS. K. R. Ferguson (Argonne National Lab., Ill.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 469-75(1963).

Considerations involved in estimating the thickness of gamma shielding for hot cells are outlined. Some simplified attenuation factor curves for making shielding estimates quickly and usually with sufficient accuracy for final design purposes are described. Significant sources of error are discussed. (M.C.G.)

393 ALPHA TRANSFER UNIT, 18 INCH (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-934)

This package contains 13 drawings. The unit allows the transfer of large items, including maintenance materials, into metal containment boxes. The boxes are used in hot cells for containment of irradiated Pu and other highly toxic nuclides. The boxes are 5 ft × 5 ft × 8 ft and are mounted on legs 3 ft high. The 18 in. transfer unit is also used for personnel access into the containment box. The box has an 18 in. opening and employs a bag ring or can. The can may be of any desired length. The can lid or the bag ring is held by tongues, which are released when a plunger is depressed. The can is positioned with its axis horizontal and is guided into a seat. Four air-operated clamps seat the can. A guillotine type door is used, which keeps the air and surfaces between the door and the can lid contamination free. When a bag ring is used, a plastic bag may be attached for use as a container for low-level gamma wastes. A suit of plastic with standard dry box gloves allows a worker to reach into the box without breaking the box integrity. (F.S.)

394 ALPHA TRANSFER MECHANISM, 7 INCH (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-933)

This package contains 10 drawings. The transfer mechanism provides mechanical sealing for stainless steel cans 8 in. in dia. and 9.5 in. long. The cans are used for semipermanent storage and inter-cell transport of radioactive materials. The transfer system, which handles the container, is of unitized construction requiring the removal of 12 nuts, one electrical connector, and one air line for the removal of the entire system. The mechanism consists of two air cylinders that hold the container in position; the lid lifting mechanism, consisting of a spring loaded bell carrying two tongs to grip the container lid; and a rotary actuator powered arm that transports the container from the loading area into position above the lower air cylinder and under the spring loaded bell. (F.S.)

Heat Transfer and Fluid Flow

395 (CNLM-4358) ENGINEERING REPORT ON THE DESIGN OF THE PRATT AND WHITNEY AIRCRAFT FORCED CONVECTION ALKALI METAL VAPORIZATION CONDENSATION HEAT TRANSFER RIG. E. Bernstein (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Jan. 18, 1963. Contract AT(30-1)-2789. 74p.

A test rig was designed to obtain basic two-phase forced-convection liquid metal heat transfer and pressure drop data for use in the design of liquid metal boilers. This engineering report includes background of the boiling problem, partial summary of work done by other investigators, the object, scope, engineering, and operation of this test rig, and a summary of reproducibility tests conducted in a water back-up rig. (auth)

396 (CUA-NE-28) SIMULATED NUCLEAR REACTOR VIBRATIONAL HEAT TRANSFER. Quarterly Progress Report, February 1, 1963–April 30, 1963. (Catholic Univ. of America, Washington, D. C.). Contract AT(30-1)-2655. 179p.

An investigation is being made in the field of high-temperature vibrational heat transfer in water systems under conditions similar to those in operating nuclear reactor systems. A program of pool heating at atmospheric pressure and at vibrational frequencies from about 10 cps to 1 mcps is established as a necessary prerequisite to a pressurized, forced convection heat transfer testing program. The lower end of the frequency range (up to 4000 cps) is to be conducted using an electrodynamic shaker as the source of the vibrations. For the higher frequencies piezoelastic ceramic transducers will be employed to provide the vibrations. Extensive operation of the high-pressure water heat transfer loop was carried out in an effort to learn as much of its operational behavior as possible, to proof check the various components of the loop, to debug its instrumentation, and to correct any inadequacies that might exist. The design of the vertical test section for the vibrational heat transfer testing program is presented. (N.W.R.)

397 (EURAEC-152) FURTHER EXPERIMENTAL DATA ON TWO-PHASE ADIABATIC FLOW: EFFECTS OF THE PHYSICAL PROPERTIES OF THE LIQUID PHASE—PRESSURE OSCILLATIONS—DENSITY MEASUREMENTS. N. Adorni, I. Casagrande, L. Cravarolo, A. Hassid, M. Silvestri, and S. Villani (Centro Informazioni Studi Esperienze, Milan). June 1961. Work Performed under United States–Euratom Joint Research and Development Program. 87p. (CISE-R-41(Pt.A))

Experimental data on film thickness, pressure drop, pressure oscillations, and density are reported for two-phase adiabatic flow in a pressurized loop. Experiments were carried out using either pure water or alcohol-water mixtures. The experimental conditions are given, and data are tabulated. (P.C.H.)

398 (EURAEC-205) FURTHER EXPERIMENTAL DATA ON TWO-PHASE ADIABATIC FLOW: EFFECTS OF THE PHYSICAL PROPERTIES OF THE LIQUID PHASE—PRESSURE OSCILLATIONS—DENSITY MEASUREMENTS.

Special Report No. 10. N. Adorni, I. Casagrande, L. Cravarolo, A. Hassid, M. Silvestri, and S. Villani (Centro Informazioni Studi Esperienze, Milan). Oct. 1961. Work Performed under United States–Euratom Joint Research and Development Program. 42p. (CISE-R-41(Pt.B))

The measurement of density by gamma and beta ray attenuation is considered. It was decided to use a $Sr^{90}-Y^{90}$ beta source, and the experimental arrangement and calibrations are described. Argon–water experiments in a loop were made at gas flow rates of 25 to 73 g/cm^2 sec and water flow rates of 26 to 135 g/cm^2 sec, and the results are expressed as liquid holdup and average density of the mixture. The densities are compared with the isokinetic extraction densities, and possible explanations for the discrepancies are discussed. (D.L.C.)

399 (NP-13103) OBOBSHCHENIE EKSPERIMENTAL'NYKH DANNYKH PO KRITICHESKIM TEPLOVYM NAGRUZKAM PRI VYNUZHDENNOM DVIZHENII NEDOGRETOI ZHIDKOSTI V TSILINDRICHESKIKH TRUBKAKH. (Generalization of Experimental Data on Critical Thermal Load in Underheated Fluid Forced Motion in Cylindrical Tubes). A. M. Ryabov and B. F. Berizina (U.S.S.R. Sovet Ministrov. Glavnoe Upravlenie po Ispol'zovaniyu Atomnoi Energii, Moscow). 1963. 29p.

A critical boiling model is suggested for vapor film formed by bubbles moving with the water stream along a container wall; for bubbles joining at active points of transformation and not dependent on forced fluid motion; and for instant bubble mixing. A system of approximation equations was used for developing similarity criteria. Experimental data indicate generalized equations for critical thermal load in pipes with ID ≥ 4 mm and ID = 2 mm. (tr-auth)

400 (NP-13275) HEAT TRANSFER IN OSCILLATING FLOW. Aeronautical Engineering Report No. 483-e, June 30, 1963. Jean-Pierre Marec and David T. Harrje (Princeton Univ., N. J. Daniel and Florence Guggenheim Labs.). July 15, 1963. Contract USN-Nonr-1858(29). 172p.

Pressure oscillations imposed upon a compressible fluid flowing in a duct produce a substantial increase of heat transfer between the heated duct wall and the fluid. An experimental investigation was made of the causes of this increase. Resonant conditions in a duct were used to achieve increased oscillating amplitudes. The local heat transfer increase was found to be highly dependent on the amplitude of the local velocity oscillations, and to depend also on the frequency of oscillations and the duct steady-state pressure and Mach number. The presence of flow reversal further increased the observed heat transfer. (auth)

401 (NP-13280) AN INDEX TO THE TWO-PHASE GAS-LIQUID FLOW LITERATURE. PART I. S. William Gouse, Jr. (Massachusetts Inst. of Tech., Cambridge, Dept. of Mechanical Engineering). May 1963. Contract NONr-1841(73). 319p. (DSR-8734-1)

A total of 2000 separate references on certain types of two-phase gas-liquid flow phenomena have been found, verified, listed, and indexed by subject and principle author. This literature survey was carried out as one phase of a program to determine the state of the art in two-phase gas-liquid flow phenomena. It is expected that this program will continue with the additional publication of critical reviews and evaluations of various problem areas in two-phase flow as well as with the publication of Part II of the Index. The problem areas of condensation, cavitation, and atomization have been excluded except when references were of such a basic character as to be generally useful. (auth)

402 (ORNL-TM-701) MEASUREMENT OF THE TURBULENT VELOCITY PROFILE OF THORIA SUSPENSIONS IN PIPE FLOW. D. M. Eissenberg (Oak Ridge National Lab., Tenn.). Nov. 14, 1963. Contract W-7405-eng-26. 87p.

Inter-particle forces present in thoria suspensions, which cause a shear dependent (non-Newtonian) viscosity, were found to affect the turbulent behavior of such a suspension in pipe flow as measured by a decrease in Fanning friction factor below that predicted for a Newtonian fluid. Turbulent velocity profiles of two concentrations of a shear-thinning aqueous suspension of thoria in a 1.60 in. brass pipe test section were obtained by means of Pitot tube traverses. Friction pressure drops across the test section were measured using static pressure taps. The test section was mounted in a circulating slurry loop, which had a maximum flow rate of 85 gpm. A vertical capillary tube viscometer was used to obtain laminar shear diagrams of the suspension from which to calculate the appropriate viscosity to use in correlation. The resulting velocity profiles and friction factor-Reynolds number plots for the dilute suspension were found to show no turbulence effects. However, the concentrated suspension friction factors were lower and the velocity profiles steeper than predicted from Newtonian fluid correlations. In addition the effective laminar sublayer thickness for the concentrated suspension was greater than Newtonian. The high concentration suspension profiles coincide with those obtained for several widely differing non-Newtonian fluids (including a visco-elastic fluid) whose friction factors also fall the same distance below the Newtonian smooth tube line. A generalized method of predicting the friction factor plot from the $u^+ - y^+$ plot for shear thinning non-Newtonian is presented. (P.C.H.)

403 (SAN-1006) ACOUSTICAL MEASUREMENT OF INCIPIENT BOILING (thesis). Report No. NE-63-1. F. H. Misch (California. Univ., Berkeley. Inst. of Engineering Research). Sept. 1963. Contract AT(11-1)-34. 52p.

A method for the experimental determination of the time to inception of subcooled nucleate boiling was developed. It consists of measuring the time between the initiation of an electrical heating step in a thin foil (or wire) and the acoustical disturbance caused by boiling on the heated surface. Tests made for steady-state pool boiling (from a single nucleating site), step-transient pool boiling, and step-transient boiling in an enclosed capsule verified the method. Heat fluxes varied from 2.2×10^4 to 161×10^4 BTU/hr-ft^2. Heating surfaces included a 0.010-inch diameter copper wire and 0.002-inch thick zirconium and stainless steel ribbons. To measure the time to incipient boiling, high speed motion pictures of the bubble growth and the oscilloscope trace from the bubble noise were taken simultaneously on the same film. An electronic scaler was used to measure boiling inception times for step-transient pool boiling on copper wire and stainless steel foil heating surfaces for three bath temperatures and a broad range of heat fluxes. (auth)

404 (TID-19596) EVALUATION OF BOILING BURNOUT TEST DATA FOR INITIAL OPERATION OF THE HIGH HEAT FLUX 19-ROD TEST SECTION AT 1000 PSIA. B. Matzner (Columbia Univ., New York. Engineering Research Labs.). May 4, 1962. Contract AT(30-1)-1808. 12p.

Forced convection boiling burnout tests were made on bundles of 19 electrically heated rods. The test section consisted of Inconel-X heater rods of 0.550 OD with a

heated length of 36 inches. The tests demonstrated that at a high mass velocity (2×10^6 lb/hr-ft^2) and low exit quality (5 to 10%) this geometry is capable of sustaining very high outer rod heat fluxes (10^6 Btu/hr-ft^2). Above 10% exit quality it appears that the burnout heat flux drops off quite rapidly. (N.W.R.)

405 THE EFFECT OF AXIALLY VARYING AND UNSYMMETRICAL BOUNDARY CONDITIONS ON HEAT TRANSFER WITH TURBULENT FLOW BETWEEN PARALLEL PLATES. A. P. Hatton and Alan Quarmby (Manchester Univ., Eng.). Intern. J. Heat Mass Transfer, 6: 903-14(Oct. 1963).

The solution is presented to the heat transfer problem with turbulent flow between parallel plates with heating on one side only. The configuration has some practical significance when considered as a limiting case of the annulus with a heated core. The velocity and eddy diffusivity variations due to Deissler are used but are modified in the central region of the passage by assuming a constant eddy diffusivity. In solving the energy equation the eddy diffusivities for heat and momentum are taken equal. The eigenvalues and functions necessary to calculate the variation of Nusselt number with distance along the passages are tabulated for three Reynolds and three Prandtl numbers. From the two basic solutions of uniform temperature and uniform heat flux the analysis is extended to certain axial variations which are of practical interest and finally, by using superposition, the result is obtained for unequal uniform heat fluxes on each side of the passage. (auth)

406 THERMAL CYCLES AND THEIR EFFICIENCY. A. L. Jaumotte. Rev. E, No. 2, 47-67(1963). (In French)

A review is presented on thermal cycles and their efficiency including some thermodynamic conceptions, energy balance of a cycle, the steam cycle, steam cycles of nuclear power stations, the binary cycle, gas cycles, combined use of steam and gas turbines, and installations with a magnetohydrodynamic generator. (TCO)

407 POOL-BOILING BURNOUT. W. R. Gambill. p.49-51 of "Nuclear Safety. Vol. 5, No. 1."

Developments in studies of pool-boiling burnout are reviewed. The influence of heat source materials and geometry, the influence of surface conditions, subatmospheric pool boiling, and burnout with cryogenic fuels are discussed. (M.C.G.)

408 OXIDATION AND HEAT TRANSFER STUDIES IN GRAPHITE CHANNELS. V. THERMAL PROPERTIES OF AIR-COOLED GRAPHITE CHANNELS. Donald G. Schweitzer (Brookhaven National Lab., Upton, N. Y.). p.241-6 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

A summary is given of work done on the thermal behavior of air-cooled graphite channels. The differences in results as compared with work done in the United Kingdom appear to arise from the different models used. Recent results and re-evaluation of previous experiments indicate that the model used in the United Kingdom work is not experimentally supported. (auth)

Materials Testing

409 (NAA-SR-8833) ELECTRODELESS DETERMINATION OF ELECTRICAL CONDUCTIVITIES OF MELTS AT ELEVATED TEMPERATURES. S. J. Yosim, L. F. Grantham, E. B. Luchsinger, and R. Wike (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 31, 1963. Contract AT(11-1)-Gen-8. 11p.

An electrodeless method for measuring the electrical conductivities of metallic and semiconductor melts at elevated temperatures is described. The transformer eddy current method, which was capable of measuring conductivities from 1 to greater than 10000 $(\text{ohm-cm})^{-1}$, was used. The system was calibrated with Hg at 25°C and tested with Hg to 300°C and Bi to 550°C. The specific conductivities of various compositions of Bi–BiI_3 solutions were measured at 500°C and compared with those measured by an electrode method. The accuracy of the method decreased with decreasing conductivity. (auth)

410 (SWRI-1296-6-5) DEVELOPMENT OF NONDESTRUCTIVE TESTING INSTRUMENTATION FOR REACTOR PRESSURE VESSELS. Third Quarterly Report, July 1–October 1, 1963. Warren J. McGonnagle (Southwest Research Inst., San Antonio). Oct. 14, 1963. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1243. 87p. (EURAEC-846)

A nondestructive testing technique for measuring the shift in the nil ductility transition temperature of A-212 Grade B steel is being developed. The experimental program is divided into three phases: establishment of experimental feasibility, determination of reliability of nondestructive test methods, and application of best methods. The first phase of the program is directed toward simulating the shift in nil ductility transition temperature resulting from metallurgical mechanisms rather than radiation effects. The first technique employed is cold rolling, which produces significant changes in the transition temperature with no obvious grain growth. Magnetoabsorption, thermal conductivity, electrical resistivity, low frequency internal friction, magnetics, and ultrasonic attenuation techniques are being investigated for determining the effect of cold work on steel. (auth)

411 X-RAY STEREO-MICRORADIOGRAPHY OF CARBONS. J. B. Nelson (Morganite Research and Development Ltd., London). p.438-55 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Contact x-ray microradiographs in stereo pairs were taken of a carbon specimen plate about 0.3 mm thick. The pairs of negatives were examined with an instrument having variable magnification; means were provided for photographing stereo transparencies suitable for use with 35 mm stereo-viewers. All particles of inorganic matter down to about 0.5 μ can be seen in depth and identification is often possible from particle morphology alone. Specific detection can be made of elements such as Cu, Ni, Co, Fe, Mn, Cr, and V occurring in particles rich in any of them; if magnifications of twenty times are adequate, the technique can be extended to Ti, Sc, Ca, and K. While pore systems can be seen directly, the contrast between carbon and small pores is not high. For this reason an electron staining procedure is used which virtually obliterates the carbon image and shows only the complex interconnecting pore channels and chambers down to about 0.5 μ in strong three-dimensional relief. Details of the apparatus and technique are given, together with examples of their application to some industrial carbons. (P.C.H.)

412 TECHNIQUE FOR MICROSCOPIC STUDIES OF GRAPHITE. R. L. Hales and E. M. Woodruff (General Electric Co., Richland, Wash.). p.456-65 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Methods were developed to obtain replicas from polished graphite and carbon surfaces for electron microscopy. By

the use of indexing techniques identical areas on sample surfaces were examined both before and after etching and neutron irradiation. The studies require that the samples be polished without the resin impregnation commonly used for graphite metallography. Conventional nuclear grade or similar graphites are machined to fit an aluminum holder in which polishing can be accomplished without impregnation. Fragile coke samples are impregnated with a water–acetone solution, frozen, and then polished in a liquid nitrogen bath. Structural details on the polished surfaces are enhanced by cathodic vacuum etching and oxidation. The methods were applied to a variety of materials including raw coke, pitch-bonded natural-flake graphite, and nuclear graphites. (auth)

413 DIRECT OBSERVATION OF IMPERFECTIONS IN GRAPHITE SINGLE CRYSTALS. Roger Bacon and Richard Sprague (National Carbon Co., Parma, Ohio). p.466-72 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

The interaction between dislocations and other imperfections in graphite single crystals was studied. Crystal step edges act as sources and tilt boundaries act as either sources or sinks for dislocations. Precipitation of foreign impurities occurs along dislocation lines or along low angle boundaries. Neutron radiation damage effectively pins dislocations, and they remain immobile after annealing to 1600°C, but begin to move after 2000°C. After annealing at 3000°C, the crystals look identical with unirradiated specimens. (auth)

Protective Structures

414 (AD-288674) AN ATTEMPT TO ISOLATE THE BLAST PHENOMENA WHICH CONTRIBUTE MOST TO THE EARTH-WALL FAILURE OF EXCAVATIONS. Technical Report No. 1717. James E. Stilwell and Andrew J. Romano (Army Engineer Research and Development Labs., Fort Belvoir, Va.). July 26, 1962. 39p.

A 100-ton high-explosive test is described. The objectives were: to obtain an insight into the blast phenomena which contribute most to the failure of earth walls of excavations and to determine the vulnerability of the two-man foxhole to blast considering the soil type existing at the Canadian test site. To accomplish these objectives, 11 test excavations were exposed to the blast at overpressure ranges of 15, 25, and 30 psi. Damage to foxholes at the 15-psi overpressure level indicated that the incident blast wave and its reflections in the excavation are primarily responsible for earth-wall damage. Damage to foxholes at the 25-psi overpressure level indicated that air-induced ground shock may be an important factor in earth-wall failure. In the soil existing at the Canadian test site, the standard two-man foxhole showed, qualitatively, a high resistance to collapse from peak overpressures ranging up to 30 psi. (auth)

GEOLOGY AND MINERALOGY

General

415 THERMAL NEUTRON ABSORPTION CROSS SECTION OF BORON. G. H. Debus, P. De Bievre, and J. Spaepen (Central Bureau for Nuclear Measurements, Euratom, Geel, Belg.). J. Nucl. Energy, Pt. A & B, 17: 349(Oct. 1963).

The ratio of B^{10} content in natural boron samples previously used to determine the thermal neutron absorption cross section of boron was measured. Discrepancies in the cross section values were partly attributed to the variation of isotopic concentration of boron with different geological origin. (C.E.S.)

416 LEAD ISOTOPE VARIATION WITH GROWTH ZONING IN A GALENA CRYSTAL. Ralph S. Cannon, Jr. (Geological Survey, Denver), Arthur P. Pierce, and Maryse H. Delevaux. Science, 142: 574-6(Nov. 1, 1963).

A large crystal of PbS from Picher, Oklahoma, has significant differences in isotopic composition of Pb in successive growth zones. Lead isotope ratios in the parent ore-fluid evidently changed with time during crystal growth. The growth history of this crystal, interpreted quantitatively, points to a tentative hypothesis of genesis of Mississippi Valley deposits of Pb and Zn. (auth)

417 CIVIL AND STRUCTURAL ENGINEERING. I. Davidson and T. C. Waters. p.585-616 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Capital economy, operating convenience, safety requirements, construction requirements, and active drainage are discussed as criteria for site layout. Engineering problems arising from the biological shield foundations, the biological shield, and the reactor containment buildings are also considered. (C.E.S.)

Natural Radioactivity and Fallout

Refer also to abstracts 15, 16, and 462.

418 (CEX-61.6.4) NORFOLK-PENINSULA AREA (ARMS-II). R. B. Guillou (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Dec. 6, 1961. Contract [AT(29-1)-1183]. 20p.

An Aerial Radiological Measuring Survey (ARMS) of the Norfolk–Peninsula area was made for the Civil Effects Test Operations, Division of Biology and Medicine, U. S. Atomic Energy Commission between Oct. 16 and 29, 1961. The survey was part of a nationwide program to measure present environmental levels of gamma radiation. Approximately 5000 traverse miles were flown, at an altitude of 500 ft above the ground, in the area, which consists of a 100-mile square centered south of midway between Williamsburg and Norfolk, Va., and a small extension on the north to overlap the ARMS-I Fort Belvoir survey. The EG&G ARMS-II instrumentation was used in the survey. The data are presented in aeroradioactivity units, or areas with similar gamma radiation rates at 500 ft, at two map scales: (1) generalized at about 1:1,000,000 and (2) detailed at 1:250,000. The aeroradioactivity in the area is less than 800 counts/sec except for four small areas in the northwest part of the area where it is less than 1200 counts/sec. In much of the area the radioactivity is less than 400 counts/sec. Aerial measurements of ground radioactivity in the ARMS-II Norfolk–Peninsula area were everywhere consistent with what was expected, considering the geology of the area. Most of the area has a low radioactivity and the surficial materials are mostly sands and gravels, which are commonly weakly radioactive. The western part of the area is slightly more radioactive, which would be expected from the older sedimentary rocks of the coastal plain exposed there in valleys. Artificial radionuclides are probably present in only small quantities because the maximum background gamma radioactivity in many places is less than 200 counts/sec. (auth)

419 (TID-19618(App.E)) CONCENTRATIONS OF GAMMA-EMITTING FALLOUT RADIONUCLIDES FROM PICEA RUBENS AND RHODODENDRON MAXIMUM OF THE GREAT SMOKY MOUNTAINS (thesis). William Kenneth Rudolph (Tennessee. Univ., Knoxville). 44p.

Branches of Picea rubens from within its canopy and branches of overstory and understory Rhododendron maximum collected from three different stations of different altitudes and with different total annual precipitation in the Great Smoky Mountains National Park were analyzed for γ radioactivity. Analyses of radioisotopes in these branches were done on 1-yr-old, older than 1 yr, stem, and leaf material. It was concluded that annual rainfall is important in bringing down radioactive fallout and also in washing radioactive material from the surface of vegetation. (C.H.)

420 Rb–Sr AND U–Pb AGE DETERMINATIONS ON THE PEGMATITE OF I MONDEI (PENNINIC CAMUGHERA-MONCUCCO-COMPLEX, ITALIAN ALPS AND SOME GNEISSES FROM THE NEIGHBORHOOD). Giorgio Ferrara (CNEN, Pisa, Italy), Bernhard Hirt, Emilie Jaeger, and Ernst Niggli. Eclogae Geol. Helv., 55: 443-50(Dec. 1962). (RT/GEO(63)32)

Results are given concerning the formation of the Camughera-Moncucco complex (Val d'Ossola, Northern Italy). Large crystals of Muscovite from a beryl pegmatite from the cava di mica I Mondei and biotite samples and muscovite samples of gneisses of the neighborhoods were measured with the Rb/Sr method. On the pegmatite, traces of the alpine metamorphism are evident. Biotites give quite young ages (18-26 MY); those of muscovites are a little higher (32 MY). Results obtained on muscovites samples from the pegmatite (200 MY) show that the muscovites with large crystals retain their radiogenic strontium even if undergone to a metamorphic action. Samples of uraninite coming from the pegmatite were also measured. Results (140-170 MY) show a loss of Pb. It was concluded that beryl pegmatite from I Mondei intruded in a pre-tertiary time. (auth)

421 ESTIMATION OF RADIOIODINE IN RAIN-OUT. Margrit Lesigang and F. Hecht (Universität, Vienna). Monatsh. Chem., 93: 369-73(1962). (In German)

The I^{131} activity, resulting from previous Soviet atomic weapon tests, contained in rainwater samples collected from the southwestern city limits of Vienna on November 4-5 and December 5-6, 1961, was estimated by gamma spectrometry. The periods between sample collection and

measurement amounted to two half lives for the first sample and one half life for the second sample. The I^{131} concentration of the first sample was about 128 pC/1, and that of the second sample about 56 pC/1. In view of the interval intervening after the weapons tests, these are reasonable decreases. These measured values are about 10^2- to 10^3-fold less than the tolerance concentration accepted at present. (BBB)

422 MOVEMENT OF RADIONUCLIDES THROUGH THE GROUND. D. G. Jacobs. p.109-14 of "Nuclear Safety. Vol. 5, No. 1."

Four general approaches for comparing the migration of radionuclides in the ground with the movement and dispersion of the transporting water involve its correlation with a qualitative description of water movement, a classical hydrodynamic description of the receiving formation, direct measurement of the hydraulic dispersion using an appropriate water tracer to obtain the solution velocity distribution, and a quantitative description of the various factors affecting radionuclide movement and dispersion. The primary concern is to describe the variation of activity in the solution phase with time and distance. (M.C.G.)

Site Survey and Selection

423 (HW-66289) AN INTRODUCTION TO THE SURFACE OF THE RINGOLD FORMATION BENEATH THE HANFORD WORKS AREA. Randall E. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1, 1960. Contract AT(45-1)-1350. 11p.

The concept of an extensively channeled, highly irregular erosion surface on the Ringold formation beneath the Hanford Works is presented. Topography and geologic history of the Ringold formation is included. (P.C.H.)

424 IAEA SYMPOSIUM ON SITING NUCLEAR FACILITIES. Wm. B. Cottrell. p.20-31 of "Nuclear Safety. Vol. 5, No. 1."

A symposium on "Criteria for Guidance in the Selection of Sites for the Construction of Reactors and Nuclear Research Centers" was held in Bombay, India, March 11 to 14, 1963. Topics covered in papers presented at the symposium are reviewed. Factors influencing site selection are listed. Power-reactor siting in the United Kingdom and in other countries, siting considerations for nuclear research centers, consequences of calculated and actual activity releases, and effects of engineered safety features on reactor siting are discussed. (M.C.G.)

Techniques and Equipment

425 METHODS OF SOIL HUMIDITY MEASUREMENT BY MEANS OF RADIOACTIVE NUCLIDES. K. Unger (Institut für Pflanzenzüchtung Quedlinburg der Deutschen Akademie der Landwirtschaftswissenschaften, Ger.). Kernenergie, 6: 465-77(Sept. 1963). (In German)

Eighteen measurement systems for indirect determination of soil moisture by gamma radiation from radioisotopes or the flux of fast neutrons from transportable neutron sources were compared. Two transportable measurement arrangements in the form of the Quedlinburger neutron screen probe as well as a remotely controlled unit for insertion of stronger Ra–Be source were illustrated further. References for standardization of the neutron probes and the most important sources of error, as well as the influence of temperature, density, and the influence of neutron retarding in the soil are given. (tr-auth)

Thorium and Uranium Minerals

426 (EUR-414.e) THE PROBLEM OF URANIUM RESOURCES AND THE LONG-TERM SUPPLY POSITION. (European Atomic Energy Community). 1963. 31p.

The situation of the natural uranium industry in the free world and its future development to 1980 is discussed. Currently listed reserves workable at \$8–10 per lb U_3O_8 are assessed to 1970. Foreseeable consumption of natural uranium between 1970 and 1980 is estimated and compared with the reserves still available. The development of the uranium market is considered more particularly as it affects the Community. Estimates of nuclear power output are given; the method used to calculate the corresponding uranium requirements is outlined. (auth)

HEALTH AND SAFETY

Refer also to abstract 1280.

427 (AD-412733) FEASIBILITY OF ACTIVE COUNTERMEASURES FOR THERMAL RADIATION EFFECTS OF NUCLEAR WEAPONS. Final Report. T. C. Goodale, M. B. Hawkins, and A. B. Willoughby (United Research Services, Inc., Burlingame, Calif.). July 1963. Contract OCD-OS-62-242. 188p.

The effectiveness and practicality of active countermeasures to the thermal effects of nuclear detonations were investigated. The use of smoke screens to attenuate the incident thermal radiation below damaging levels appeared to be the most practical countermeasure for large-area application. The investigation included review of available information on active countermeasures, study of radiation attenuation by individual particles and clouds of particles, study of the theory of smoke-producing reactions, development of preliminary smoke-screen system design procedures, and preliminary cost-effectiveness analyses of several candidate smoke-screen systems. The major conclusions are: (1) Smoke screens composed of absorbing particles appear to be more effective and less expensive than screens composed of scattering particles; (2) Effective screens can be produced and maintained under a wide variety of weather conditions; (3) Anticipated costs of smoke-screening systems are estimated to be as low as $100,000 per square mile; and (4) Wind-dispersed screens appear to be the most practical at present. Recommended are rapid development of prototype hardware for interim screening systems as well as a research and development program leading to screening systems with optimum performance for minimum cost. (auth)

428 (AERE-R-4384) RADIOACTIVE FALLOUT: SHORT-LIVED FISSION PRODUCTS IN AIR AND RAIN, AUGUST 1962–APRIL 1963. R. S. Cambray and E. M. R. Fisher (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1963. 37p.

Short-lived fission products from the nuclear test explosions of 1962 were studied for the period August 1962 to April 1963. Total beta, barium-140, iodine-131, and zirconium-95 activities were estimated in samples of atmospheric dust and rainwater. The concentration of barium-140 in surface air at Chilton (Berkshire) attained a maximum value of 3.1 pc/kg of air on 10th November 1962. The concentration of iodine-131 in air was on average about half that due to barium-140. Dry deposition velocities and washout factors for particulate matter by precipitation increased sharply during late December 1962 and early January 1963. (auth)

429 (CEX-62.03) GENERAL CORRELATIVE STUDIES—OPERATION BREN. J. A. Auxier, F. F. Haywood, and L. W. Gilley (Oak Ridge National Lab., Tenn.). Sept. 1963. Contract [W-7405-eng-26]. 40p.

A summary of the utilization of the Health Physics Research Reactor and a Co^{60} source during Operation BREN was prepared, and the pertinent meteorological data are tabulated. Normalization factors for air dose, as it depends on air density and reactor power level, are obtained as a function of source height; typical dose vs. distance curves are presented. For a source height of 1125 ft and with the detector at the surface of the ground, the relaxation length in air is 230 yards for neutrons from the reactor, 311 yards for gamma radiation from the reactor (including gamma rays from inelastic interactions by neutrons in air), and 256 yards for the gamma rays from Co^{60}. These reduce to 181, 245, and 200 yards, respectively, at 760 mm Hg pressure and 0°C. This is the third of a series of Operation BREN reports and the first concerning experimental results. (auth)

430 (EUR-359.f) L'ACTION INTERNATIONALE DANS LE DOMAINE DU CONTROLE MEDICAL. (International Activities in the Field of Medical Inspection). P. Recht (European Atomic Energy Community). 1963. 19p. (CONF-257-1)

From Medical Supervision Workers Exposed to Ionizing Radiation, Stresa-Ispra, Italy, May 1961.

The basic standards of radiological protection established by Euratom in Feb. 1959 are examined in detail with respect to their content and consequences for the organization of community medical services for dealing with the hazard of ionizing radiations. The sphere of application, means whereby medical control may be exercised, training and certification of physicians, training of other workers, the standardization of medical files, and research work on radiological protection are discussed. (C.H.)

431 (HASL-139) AEROSOL PENETRATION THROUGH 9 mil HV-70 FILTER PAPER WITH AND WITHOUT PINHOLES. J. W. Thomas and G. D. Crane (New York Operations Office. Health and Safety Lab., AEC). Aug. 1963. 24p.

Studies were made of the penetration of two polydispersed dioctylphthalate aerosols of different particle size distribution through 9 mil HV-70 type filter paper with and without pinholes at several different air velocities. It was found, as was expected from elementary considerations, that the penetrations of the two aerosols of different particle size differed greatly for an intact filter, but approached the same value for the filters containing pinholes. This result implies that in testing filters or filter installations for leaks, aerosol particle size is much less important than in evaluating filter materials per se. To account for the pinhole effect, a generalized equation was developed which relates change of aerosol penetration through a filter to air linear velocity. This equation was confirmed within limits. (auth)

432 (HW-67197) EFFECT OF PLUTONIUM-241 ON THE MAXIMUM PERMISSIBLE CONCENTRATION IN AIR AND MAXIMUM PERMISSIBLE BODY BURDEN FOR EXPECTED ISOTOPIC MIXTURES OF PLUTONIUM. L. C. Rouse (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 14, 1960. Contract AT(45-1)-1350. 13p.

The maximum permissible concentration in air and the maximum permissible body burden for Pu increases as the wt % of the Pu^{241} increases. This occurs because the permissible limits for Pu^{241} are less restrictive than those for the Pu α emitters, in terms of activity. However, if the contribution of the Pu^{241}, a low energy β emitter, is not measured, the permissible limits for the Pu α emitters must be reduced in proportion to the percentage of Pu^{241}. To apply the correct permissible limits for Pu, the activity of the Pu^{241} must be measured or the wt % must be known. Recently installed liquid scintillation equipment will permit analysis of urine samples for Pu^{241}. At present

no method is available for field use to measure the Pu^{241} in air samples, and often the Pu composition will not be known for cases of air contamination. In view of this and other factors, continued use of 2×10^{-12} μC/cc is recommended as the maximum permissible concentration in air for Pu. Plutonium containing varying high percentages of Pu^{241} and Pu^{240} will be a product of the Plutonium Recycle Test Reactor. (auth)

433 (HW-SA-3197) PARTICLE SIZE DISTRIBUTION FOUND IN AIR AT HANFORD PLUTONIUM FABRICATION FACILITIES. B. V. Andersen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 12, 1963. Contract AT(45-1)-1350. 29p. (CONF-279-1)

From 7th Annual Western Industrial Health Conference, San Francisco, Sept. 1963.

The conventional sampling methods of filtration and impaction are generally utilized in the collection of air samples at Hanford. In addition, a Goetz aerosol spectrometer is available for special studies. Particle-size determinations are made by autoradiographic studies making use of both optical and electron microscopes. A supplementary tool sometimes utilized is the Royco Particle Counter. The study included an analysis of the potential usefulness and the limitations of these air sample study methods for plutonium aerosol particle size measurement. Preliminary results, from a continuing study of the particle size distribution in normal and abnormal air, show particle sizes ranging from hundredths to tens of microns. The studies include considerations of the usefulness of particle size data in planning biological experiments and in the application of these data to human internal deposition cases. (auth)

434 (LADC-5967) PROBLEMS IN THE APPLICATION OF DIRECT READING INSTRUMENTS OR DEVICES. H. F. Schulte (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 14p. (CONF-259-1)

From National Safety Congress, Chicago, Oct. 1963.

A discussion is presented of the uses of direct-reading instruments in the evaluation of industrial hazards, e.g., chemicals in the air, radiation, etc. The nature of threshold limit value and the variables affecting the dose exposure and susceptibility are considered. The two different classes of direct-reading instruments are described: these that give a dial reading, and these that produce a color change. The limitations of colorimetric tubes and papers are discussed in some detail. The importance of relating the probability of the measurement being correct with the threshold limit value curve is emphasized. The role of direct-reading instruments in the industrial health program is discussed. (D.L.C.)

435 (LADC-5971) RESPIRATOR FILTER TESTING AT LOS ALAMOS. R. N. Mitchell and H. J. Ettinger (Los Alamos Scientific Lab., N. Mex.). Sept. 10, 1963. Contract W-7405-eng-36. 10p. (CONF-255-1)

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

Since most of the used high-efficiency filter cartridges from respirators at Los Alamos were not contaminated, reuse of the uncontaminated filters was considered. A DOP respirator filter tester was used to determine the efficiency of new and used filters, and the results are tabulated for a large number of filters. It is concluded that over a 2- to 3-year period, the savings realized by reuse of old filters will more than pay for the DOP tester, and that the tester can also be used to detect manufacturing defects in new filters. (D.L.C.)

436 (LAMS-2879) PLANTS AS MONITORS OF RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT OF LOS ALAMOS, NEW MEXICO. E. R. Graham (Los Alamos Scientific Lab., N. Mex.). Aug. 15, 1962. Contract W-7405-eng-36. 18p.

A study of the radioactive contamination of plants of Los Alamos, N. Mex., revealed them to be suitable monitors of the environment. The results of an analysis of the β activity found in the ash of grass samples from the area showed that the beta activity in the ash due to K^{40} was in no case more than 10% of the observed activity. The low values obtained on most of the samples obtained at Los Alamos were higher than the highest values obtained on samples from Española and Santa Fe. Gamma-ray spectrum analysis of the grass and pine needle pellets along with analysis of digested air filters revealed the principal gamma activity to be due to the fission products Zr–Nb, Ru–Rh, and Ce–Pr. There were some samples that contained small amounts of I^{131}. (auth)

437 (NDL-TR-28) A COMPILATION OF CAMP CENTURY ENVIRONMENTAL MONITORING DATA FROM MAY 20, 1960 TO JUNE 30, 1961. Robert J. Nicoll, David T. Kilminster, John W. Kinch, and John H. McNeilly (Army Chemical Corps Nuclear Defense Lab., Army Chemical Center, Md.). Apr. 29, 1962. Mar. 1962. 22p. (AD-293649)

Results are presented of the first 58 weeks of the U. S. Army Environmental Monitoring Program for the package power reactor located at Camp Century, Greenland. Alpha and beta activities of snow and water samples are reported in microcuries per milliliter. Similar measurements of air samples are reported in microcuries per cubic centimeter of air. Beta-gamma survey readings of the sampling stations are also included. All observed sample activities were below the maximum permissible concentrations recommended by the Atomic Energy Commision. (auth)

438 (NLCO-889) EXHAUSTING CORROSIVE FUMES WITH QUICKDRAFT EDUCTORS. Robert B. Boies (National Lead Co. of Ohio, Cincinnati). Sept. 1, 1963. Contract AT(30-1)-1156. 18p. (CONF-255-8)

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

The uses of Quickdraft eductors in handling and diffusing various types of corrosive fumes are described. A number of specific applications are discussed and illustrated. (auth)

439 (NP-13126) CIVIL DEFENSE MANUAL FOR RADIOLOGICAL DECONTAMINATION OF MUNICIPALITIES. C. Herbert Wheeler, Jr. and Mario V. Cammarano (Curtiss-Wright Corp. Curtiss Div., Caldwell, N. J.). Aug. 1963. Contract OCD-OS-62-279. 416p.

Radiological defense consists primarily of protection from fallout. This manual covers the operational recovery phase of radiological defense, which is concerned with decontamination of structures and areas made dangerous or lethal by fallout. It assumes that no significant damage has been sustained in the area due to blast or fire. The physical phenomena associated with nuclear detonations and the biological effects of the associated radioactive fallout are described. The problems of municipal planning for radiological defense are discussed, and a plan for an actual American city is included as an example. Detailed technical information on methods of decontamination is presented. The instructions cover the cleaning of building structures, pavement, and natural areas. One chapter deals with cold weather decontamination problems. The efficiencies of decontamination methods and equipment are evalu-

ated in terms of human effort. Analytical procedures are developed, including estimating and worksheet forms, for municipal radiological defense planning. These procedures are applied in a hypothetical case history of a municipal defense zone. (auth)

440 (NP-13235) TRANSPORTATION OF IRRADIATED FUEL FROM N. S. SAVANNAH REACTOR. Safeguards Report ST-SI. J. W. Allen, G. Fisher, and R. L. Barnett (Stanray Corp., Chicago). June 19, 1961. Contract MA-2239. 149p.

Presented are the complete design, operating procedures, and evaluation of the health-safety aspects for shipment of irradiated fuel from the temporary storage site operated by Todd Shipyards to the AEC reprocessing site. Except for minor differences, the proposed shipments meet the rules proposed by the AEC in the May 17, 1961, Draft of Part 72 Regulations for Transportation of Irradiated Materials. The only exception of importance is the elimination of a particulate filter in the rupture disc pressure relief system which is provided for extreme emergencies only. The results of the calculations and evaluation of the various factors are given. Safety in operation governed the procedures outlined for this transportation. A steel granular coolant can be used in this cask but due to high temperatures of the fuel and other operational problems, it is felt that the proposed atmospheric pressure-water cooled cask is the best solution. The shipments will move by railroad under a government bill of lading and on the special railroad car described herein. It is proposed that the shipment will move from Galveston, Texas, to the Savannah River processing site. The facilities at the loading and unloading site will be adequate to handle the proposed equipment. (auth)

441 (NP-13260) SMALL-SCALE DECONTAMINATION OF RADIOACTIVE WATERS BY ION EXCHANGE. Michael B. Sonnen and Arliss D. Ray (Vanderbilt Univ., Nashville. School of Engineering). Mar. 1, 1963. Contract OCD-OS-62-110. 75p.

Immediately following nuclear war events, it is anticipated that surface waters will be contaminated by radioactive fallout materials and it appears desirable to minimize the amounts of ingested radioactive materials for a period of time to reduce the radiation doses of the population. Although drinking waters free of radioactivity may be provided by prior storage, or decontamination may be achieved to an acceptable degree by emergency means utilizing materials common to most households, there is still an apparent need for a small-scale commercial decontamination unit. In order to supply an appropriate basis for design of such small-scale commercial units, it has been necessary to determine the chemical and physical natures of the radiocontaminants, to review the various methods available for decontamination and their respective performance in laboratory and field experiments, and to select suitable decontamination methods in relation to the anticipated problem. The basic design criteria are those of simplicity, of capability, and of reasonably low cost; the ion exchange process is apparently most appropriate for this purpose. Laboratory studies have shown that turbidity or suspended solids, particularly clay minerals, in the raw waters impose a limitation on the ion exchange process, and it is desirable to require prior filtration of the raw waters. Specific laboratory studies were conducted to determine the relationship between suspended solids and ion exchange resins and to ascertain the effect of suspended solids on the removal of radiostrontium by ion exchange resins. A decontamination unit which includes both filtration and ion exchange, using synthetic ion exchange resins, is specified, and considerations in the design of the unit are enumerated. A decontamination unit meeting the prescribed criteria would be reasonably simple in operation and would be capable of adequate decontamination performance; however it appears that the cost of the unit would be greater than desired. A detailed study of the relative costs of the decontamination unit and alternate sources of uncontaminated waters, such as emergency stores of water, is desirable under the circumstances. Preliminary estimates indicate the decontamination unit would not be more economical than stored water unless the total volume of required water exceeded two or three hundred gallons. (auth)

442 (NP-13262) A METHOD FOR ESTIMATING DEPOSITION PATTERNS OF RADIONUCLIDES IN WORLD-WIDE FALLOUT. Carl F. Miller (Stanford Research Inst., Menlo Park, Calif.). Sept. 1963. 24p.

The nature of world-wide fallout and the manner in which it is deposited are discussed in terms of a very simplified model. The parameters that influence the deposition patterns are given for computing the deposition patterns of individual radionuclides. (D.L.C.)

443 (NP-13278) PROCEEDINGS OF THE NORTH CENTRAL EXPERIMENT STATIONS WORKSHOP ON RADIONUCLIDES IN FOODS AND AGRICULTURAL PRODUCTS, FEBRUARY 19–21, 1963, CINCINNATI, OHIO. Special Report Series No. 1. F. Haghiri and R. R. Johnson, eds. (Ohio. Agricultural Experiment Station, Wooster). June 1963. 147p.

Contamination of food and water represents the primary pathway by means of which the human population is exposed to radiation from world-wide or local fallout. Pathways of radioisotopes in the food chain are reviewed, with emphasis on Sr^{89}, Sr^{90}, Cs^{137}, and I^{131}. The role of milk in the transfer of fallout radioactivity to man is considered. Countermeasures against fallout contamination are discussed. It is pointed out that actions and procedures that would result in reducing or eliminating the exposure of the population to the hazards of radioactive materials should be directed to the source of the contamination, to the mechanism that transmits it, or to the substance in which it gains access. Available measures and current research are reviewed on measures to reduce the radioactive contamination of soils, plants, milk, and other food items. (C.H.)

444 (NRL-5970) FILTER PACK TECHNIQUE FOR CLASSIFYING RADIOACTIVE AEROSOLS BY PARTICLE SIZE. PART 1. PRELIMINARY REPORT AND EVALUATION. L. B. Lockhart, Jr. and R. L. Patterson, Jr. (Naval Research Lab., Washington, D. C.). Aug. 16, 1963. 10p.

Study of the efficiency of filters for the retention of natural airborne radioactive aerosols showed that the particles with which the radioactivity of the short-lived radon daughters is associated have greater ability to penetrate the various filter media that has the fission product debris in the atmosphere; therefore the former is associated with aerosols of smaller size. A preliminary evaluation of the techniques of employing packs of filters of different retentivity characteristics to determine the particle size and/or particle size distribution of radioactive aerosols indicated the feasibility of the method. (auth)

445 (NVO-162-1) OPERATION NIBLICK. PRELIMINARY REPORT — U3bw PEKAN EVENT. James D. Kimmel (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). [nd]. Contract AT(29-2)-162. 17p.

Data on fallout monitoring for I^{131}, I^{133}, and I^{135} after an

underground explosion in Yucca Flats, Nevada, are presented. The monitoring system is also described. (P.C.H.)

446 (NVO-162-3) DOMINIC SERIES. NEVADA PHASE. On-Site Radiological Safety Report. F. Dean Rowsell and Victor M. Milligan (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). Oct. 23, 1962. Contract AT(29-2)-162. 101p.

The Dominic Series, Nevada Phase, was a group of 4 low-yield underground nuclear detonations carried out at adjacent sites at the Nevada Test Site during the month of July 1962. Radiological safety activities were initiated prior to the first event and continued until no significant radiological health hazards remained in the area. Sampling and measurement data are presented for the entire series. No unusual radiological problems were encountered. (C.H.)

447 (RTD-TDR-63-3049) BIOLOGICAL DOSIMETRY OF IONIZING RADIATION AS APPLIED TO TRIAGE OF CASUALTIES FOLLOWING A THERMONUCLEAR DETONATION. Lawrence T. Odland (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Oct. 1963. 25p. (AD-421596)

The need for sorting of casualties following a nuclear disaster is discussed. The problem of radiation illness imposed upon conventional traumatic injuries and burns is emphasized. Arguments are presented for the need of a simple yet accurate biological dosimeter to aid medical officers responsible for casualty sorting. Criteria of an ideal biological dosimeter are proposed, and developments are reviewed. It is pointed out that at present the fall in leukocyte count, especially the lymphocytes, following exposure is the simplest and most practical method of estimating biological injury resulting from ionizing radiation. (auth)

448 (EURAEC-215) REPORT CONCERNING THE STUDY OF THE TRANSPORTATION OF IRRADIATED FUEL FROM THE SENN REACTOR AT GARIGLIANO (ITALY). Special Report No. 1. (Lebon et Cie., Paris and Société Générale d'Exploitations Industrielles, Paris). Oct. 1961. Work Performed under United States–Euratom Joint Research and Development Program. 49p. (A translation).

Irradiated fuel is to be shipped from the SENN reactor in Italy to Savannah River Plant in U.S. for reprocessing at the end of 1964. One possible solution to the numerous problems involved in such transfer is selected as an example and its aspects examined in detail. The operations and means of transportation are described in detail, along with the steps to be taken in case of accident. Legal, insurance, and cost questions are considered. (D.L.C.)

449 RADIATION INTENSITY AND RADIATION DOSE: A NEW PROPOSAL FOR THE ELIMINATION OF THE PRESENT CONFUSION IN RADIATION MEASUREMENTS. H. R. Schinz (S. A. Brown, Boveri & Cie, Zurich) and R. Wideroee. Deut. Med. Wochschr., 88: 1043-50 (May 17, 1963). (In German)

Problems encountered in measuring the intensity of the radiation field and the absorbed dose in medical radiology are discussed, and a new unit for representing radiation intensity values is proposed. To arrive at a clearer definition, tion, the absorption of radiation in the ambient air is neglected and dose is assumed to relate to the amount of radiation absorbed by liquid or solid structures. The difficulties which have heretofore been experienced in using the roentgen unit to quantitate this concept of dose are enumerated, and it is suggested that the roentgen be replaced by a new unit, the planck (P), which is equivalent to a radiation field density of 3000 erg/cm^2. This unit corresponds to the term energy-fluence proposed by the International Commission on Radiological Units in 1962 for radiation field intensity. The relations of these units to the rho and rad are discussed, and it is suggested that the roentgen and rho be used only for actual measurements of radiation intensity and dose, respectively, and as guides for evaluation of the corresponding absolute units, planck and rad. The latter units can be used to express almost all radiometry and dosimetry parameters, and in most energy ranges are numerically similar to the respective roentgen and rho values. Equivalent values over various energy ranges are tabulated, and most frequently used radiation units are defined and their interrelations discussed. (BBB)

450 PREPAREDNESS FOR EMERGENCY FEEDING. Kathleen R. Creech (Air Force, Washington, D. C.). J. Am. Dietet. Assoc., 42: 125-7(Feb. 1963).

Four emergency feeding plans as part of a civil defense program are presented. (BBB)

451 IRRADIATION HAZARDS FIRST AID IN ISOTOPIC LABORATORIES. K. Neumeister (Strahlentherapeutische Klinik der Medizinischen Akademie, Magdeburg, Ger.). Kernenergie, 6: 516-19(Sept. 1963). (In German)

The possiblity of first aid for radiation accidents in isotope laboratories is reported. After a description of the injuries from internal or external irradiation of an organism, modes of action for the first aid, especially for contamination and injury of the skin as well as for fresh incorporation, are presented. (tr-auth)

452 REPORT ON RADIOACTIVE FALLOUT. Medd. Sundhedsstyr., 122: 904-5(Dec. 14, 1962). (In Danish)

A brief summary of fallout levels in Scandinavian countries is reported. (BBB)

453 CONCERNING THE DETECTION OF FISSION PRODUCTS IN RAIN WATER IN THE VICINITY OF VIENNA (MAY TO DECEMBER 1962). E. Schmid, Margrit Lesigang, and K. Buchtela (Universität, Vienna). Mikrochim. Ichnoanal. Acta, No. 3, 552-60(1963). (In German)

A description is given of the processing of radioactive rain waters collected in the vicinity of Vienna. To simplify a γ-spectrometric identification of the fission products present in the rain waters, a group separation was made by precipitation with nonisotopic carriers. In addition, tests were made to detect losses of active materials during all of the chemical operations employed, for instance by adsorption. (auth)

454 HYGIENIC ASPECTS OF TRITIUM FORMATION IN HEAVY-WATER REACTORS. Carl-Eric Holmquist (Kungl. Tekniska Högskolan, Stockholm). Nord. Hyg. Tidskr., 42: 277-95(1961). (In Swedish)

Hazards are discussed relating to the tritium activity induced in heavy-water-moderated and -cooled nuclear reactors after a few years of operation. This becomes a problem of considerable hygienic significance. Unlike the fission product activity, T_2O is, on account of its appreciable vapor pressure, a constant hazard. It necessitates a careful industrial hygiene surveillance and a well-balanced ventilation system, and causes problems by permeating protective clothing. The discharge of liquid effluent of low-level tritium activity to lakes requires careful study of their capacity as a recipient for tritium, since ordinary waste treatment fails to reduce this activity. (BBB)

455 SOME EXPERIMENTS ON THE MEASURING TECHNIQUE OF BONE MARROW DOSE. Shigetoshi Antoku (Hiroshima Univ.) and Noritoshi Watanabe. Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, 23-30(1961).

Phantoms, with and without inserted bone structures,

were used to calculate the radiation dose to bone marrow during fluoroscopic examination of the gastrointestinal tract. The contribution of scattered radiation to total dose was also calculated. (C.H.)

456 DOSIMETRIC CONTROL. M. I. Gneushev, V. I. Bad'in, and E. A. Fishevskaya. Radiats. Gigiena, Sb., 1: 126-34(1962).

Principles of general and individual dosimetric control, the chief instruments for recording of x-ray, β-, and γ-radiations, n dosimetry, and measurement of radioactive aerosols and gases, are described. (Ref. Zh., Khim. 1963)

457 THE CHANGED MEANING OF THE DOSE CONCEPTS AND CONCLUSIONS FOR DOSAGE. H. Hegewald (Universitäts-Geschwulstklinik der Medizinischen Fakultat, Berlin). Radiobiol. Radiotherap., 4: 483-90(1963). (In German)

Starting from the original definition of dose-quantity and the r-unit it is pointed out that till now to some extent the interpretation is to be found, that the r-unit is the unequivocal measure for dosage and the biological effect, respectively. However, the more exact new definitions make it possible to dose in rad and restrict the r-dosage to the field of physical measurements. The advantages as well as some problems of energy absorption and conversion in the case of bone-tissue interfaces are represented. (auth)

458 STRONTIUM-90 ACCUMULATION ON PLANT FOLIAGE DURING RAINFALL. Ronald G. Menzel (Agricultural Research Service, Beltsville, Md.), Howard Roberts, Jr., Ernest H. Stewart, and Arnold J. MacKenzie. Science, 142: 576-7(Nov. 1, 1963).

Accumulation of Sr^{90} in field-grown crops was measured during the spring of 1962. Each rainfall markedly increased the Sr^{90} content of the crops, except when the plants were very small. Accumulation between rains was comparatively small, about equal to the expected uptake from the soil. (auth)

459 IDEALS AND RESPONSIBILITIES OF THE RADIOLOGIST. Seymour Fiske Ochsner (Ochsner Clinic, New Orleans). Southern Med. J., 56: 752-9(July 1963).

Duties of radiologists, including the maintenance of radiation hygiene in their departments, are reviewed. (BBB)

460 ACCIDENTS DURING THE TRANSPORTATION OF RADIOACTIVE MATERIALS. H. Marcinowski. Versicherungswirtschaft, No. 16, 3-7(Aug. 1963). (In German)

Information is given on accidents that have taken place in the German Federal Republic during the transportation of radioactive materials by rail, road, air, and water, and in which phase of the transportation the accidents have occurred. The loads are divided up according to their radiation characteristics and activities, and the accidents during transportation according to the radioactive materials that fall into two main groups, fission products and radio nuclides. (TCO)

461 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME IV, NUMBER 3. (Public Health Service, Washington, D. C.). Mar. 1963. 50p. $0.50(GPO) (RHD-Vol.IV, No.3)

Data are presented on fission product radioactivity in samples of airborne particulates, precipitation, and surface water collected at various locations throughout the U. S., Canada, and Mexico during 1962. Data are included on the daily consumption of milk, apples, lettuce, beef, and white bread by sex and region throughout the U. S.; the Sr^{90} content of the diet in selected areas; and the Sr^{90} activity in U. S. soil and wheat from 1958 through 1962. Results are included from a survey of Sr^{90} content in the diet in the United Kingdom from 1958 through 1961. Results are included from the analysis of milk samples collected throughout the U. S. and Canada during 1961 and 1962 for fission product activity with emphasis on the content of Sr^{89}, Sr^{90}, and I^{131}. Environmental levels of radioactivity during 1961 and 1962 are reported for the Feed Materials Production Center, Fernald, Ohio, and the Mound Laboratory, Miamisburg, Ohio. Data are summarized on nuclear detonations reported during Feb. 1963. (C.H.)

462 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME IV, NUMBER 6. (Public Health Service, Washington, D. C.). June 1963. 50p. $0.50(GPO). (RHD-Vol.IV, No.6)

Data are presented on fission product radioactivity in samples of airborne particulates, precipitation, surface waters, and milk collected throughout the U. S., Canada, and Mexico during Feb. 1963. Results are included from measurements of the content of Sr^{90} in Canadian wheat from 1957 to 1961; the content of Sr^{89}, Sr^{90}, and I^{131} in milk samples during 1962 and 1963; the radionuclides in the Northwestern Alaska food chain from 1959 to 1961; radionuclides in diets for teenagers during 1962 and 1963; and the Sr^{90} content in the diet of residents of New York City, Chicago, and San Francisco during Aug. and Sept. 1962. Data are included on the environmental radioactivity levels at the National Reactor Testing Station, Idaho Falls, Idaho, and the Pinellas Peninsula Plant, St. Petersburg, Florida, during 1962. Data are summarized on the one nuclear detonation announced during May 1963. (C.H.)

463 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 32, JANUARY-MARCH, 1963. Tokyo, The Japan Meteorological Agency, 1963. 104p. (In English and Japanese)

Data are presented on fallout radioactivity in samples of rain water, atmospheric particulate materials, and sea water collected at various stations throughout Japan from Jan. to March, 1963. (C.H.)

464 NUCLEAR SAFETY. Volume 5, No. 1. William B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Fall 1963. (GPO) $0.55 (domestic), $0.70 (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). (TPR-NS-Vol.5, No. 1)

Reviews on selected subjects in nuclear safety are presented under 26 topics. Separate abstracts were prepared for 25 of the articles; one was previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 41, 141, 244, 245, 380, 407, 422, 424, 465, 466, 467, 468, 469, 470, 471, 1181, 1182, 1183, 1197, 1213, 1220, 1265, 1266, 1267, and 1311.

465 SAMPLING CONSIDERATIONS IN MONITORING PROCESS-WASTE EFFLUENTS. D. J. Knowles. p.59-62 of "Nuclear Safety. Vol. 5, No. 1."

Techniques of sampling for monitoring process-waste effluents are discussed. Topics covered include: representative sampling, losses in sampling system, accuracy, sampling frequency, and total flow measurements. (M.C.G.)

466 HAZARDS OF HYDROGEN HANDLING. C. J. Barton. p.84-7 of "Nuclear Safety. Vol. 5, No. 1."

The hazard aspects of the use of hydrogen as a coolant and the handling of liquid hydrogen are reviewed. (M.C.G.)

467 WORLDWIDE RADIOACTIVE FALLOUT FROM NUCLEAR TESTS. PART II. L. Machta. p.95-104 of "Nuclear Safety. Vol. 5, No. 1."

Atmospheric transport of bomb-produced radioactive fallout is discussed. The earth's atmosphere is described.

Seasonal trends and the geographical distribution in stratospheric fallout are discussed and interpreted in terms of the known behavior of the atmosphere. Tropospheric fallout is also considered. Two special tracers, W^{185} and Rh^{102}, were added to the atmosphere in nuclear tests by the United States in 1958 to study atmospheric transport. (M.C.G.)

468 CLOTHING FOR USE IN CONTAMINATION ZONES. H. M. Butler. p.104-9 of "Nuclear Safety. Vol. 5, No. 1."

Protective apparel currently in use is, in general, of two types: clothing to protect personnel from loose radioactive material of low or moderate concentration in a chemical or physical state that presents a potential for radiation exposure by uptake through external body surfaces or by becoming affixed to external body surfaces and clothing for protection against loss radioactive material in high concentrations or material that has the ability to diffuse through and counteract the effectiveness of clothing belonging to the first category. Respiratory-protection equipment is also considered. (M.C.G.)

469 ACCIDENTS IN SHIPPING RADIOACTIVE MATERIAL. L. B. Shappert. p.123-7 of "Nuclear Safety. Vol. 5, No. 1."

Safeguards against accidents in shipping of radioactive material are discussed. Data were analyzed on the type and frequency of accidents involving the shipment of both nonradioactive and radioactive materials. During the 5-yr period from 1957 to 1961, a total of 47 accidents occurred in shipments by AEC or its contractors. Six were on-site accidents and were eliminated for the purpose of establishing an accident frequency rate. A rate of 8.2 accidents per year in 47,000 shipments per year gave an accident frequency rate of 0.17 accident per thousand shipments. The accidents were also classified according to type. (M.C.G.)

470 CHANGES IN LICENSING REGULATIONS. J. R. Buchanan. p.135-6 of "Nuclear Safety. Vol. 5, No. 1."

Amendments proposed for AEC rules and regulations pertinent to nuclear safety are discussed. (M.C.G.)

471 SAFEGUARDS REPORTS AND SELECTED READING. J. R. Buchanan. p.136-8 of "Nuclear Safety. Vol. 5, No. 1."

The recently issued safeguards reports and selected literature pertaining to hazards of reactors are listed. (M.C.G.)

472 CENDRILLON CONTAINERS FOR THE TRANSPORT AND DISPENSING OF RADIOACTIVE LIQUIDS. Jean Vertut (Commissariat a l'Energie Atomique, Saclay, France). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 339-45(1963).

Pumpkin-shaped containers were developed for safe transport and dispensing of radioactive liquids. Four different sizes varying in capacity from 3.5 to 50 liters are available. However, liquids with criticality hazards cannot be handled in these containers. The shape was chosen to make the container rest firmly on a flat surface and to prevent it from being turned over and remaining upset. The liquid is held in an inner container of stainless steel. It is surrounded by a protective lead shell made in two halves, so that the upper half can be taken off. The lead itself is cast into steel shells to provide additional strength. Both halves are rendered liquid tight by asbestos packing. (M.C.G.)

473 CRITERIA FOR SAFE HANDLING OF IRRADIATED PLUTONIUM IN BETA-GAMMA SHIELDED CELLS. Leo G. Faust, J. G. Bradley, and C. L. Boyd (General Electric Co., Richland, Wash.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 437-45(1963).

No known significant internal body depositions result from handling irradiated plutonium-bearing materials when alpha emitting contaminants are controlled by beta-gamma monitoring of associated fission products. This method is in use by the Hanford Laboratories Radiometallurgy Facility. Irradiation data are used to establish when a sample must be removed from the laboratory. This assures existence of a beta-gamma to alpha activity ratio above a prescribed value during sample retention in the laboratory. (auth)

INSTRUMENTATION

General

Refer also to abstracts 434, 659, and 724.

474 (AAEC/M-67) TRANSISTORISED TEMPERATURE CONTROLLER A.A.E.C. TYPE 30. L. B. Ackland (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1963. 15p.

This manual gives a description, operating instructions, circuit diagram, and parts list of Transistorized Temperature Controller type 30 designed in the laboratories of the Australian Atomic Energy Commission. (auth)

475 (AED-C-06-08) AUSGEWÄHLTES SCHRIFTTUM NACH SACHGEBIETEN. MESSINSTRUMENTE UND MESSVERFAHREN DER KERNPHYSIK. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Measuring Instruments and Measuring Procedures of Nuclear Physics. Bibliographic Compilation). Klaus Debertin, comp. (Johann-Wolfgang-Goethe-Universität, Frankfurt am Main. Institut für Kernphysik). May 1963. 127p.

A bibliography containing 563 references on nuclear physics measuring instruments and methods is presented. The issue contains mainly publications abstracted in NSA and works published up to December 1962 in some selected German periodicals or in Nuclear Instruments and Methods. Indexes are given for the authors, index numbers, report numbers, subjects, and conferences. (N.W.R.)

476 (ARL-63-151(p.596-614)) A MINIATURE ENTHALPY PROBE. Frederick C. Haas (Cornell Aeronautical Lab., Inc., Buffalo).

A small calorimetric enthalpy probe capable of continuous operation in a high-temperature, high-heat flux environment, as in an arc is described. The instrument has given enthalpy values within 2% of those obtained by conventional methods at temperatures of 2100 to 4250°R using nitrogen as the test gas and water as the evaporative coolant. An instrument for continuous measurement of the gas sample composition is also described. (auth)

477 (NP-13198) SENSITIVITY OF TWIN-T BRIDGE SYSTEM AS A NUCLEAR MAGNETIC RESONANCE DETECTOR. Technical Report, Series B, No. 1. Kiyoshi Kume (Tokyo Univ. Inst. for Solid State Physics). Mar. 1960. 7p.

Relations for the noise figures of the bridge and the system were derived; experimental noise figures agreed satisfactorily with the predictions of these relations. An examination of the dependence of the system noise figure on the r-f voltage applied across the sample coil indicates that the r-f generator before the bridge contributes extra noise at higher r-f levels. Reduction of the extra noise would improve sensitivity. (D.C.W.)

478 (NP-13201) SERVO MOTOR DE CONTROL. INFORME NO. 84. (Control Servo-Motor. Report No. 84). Carlos Marazzi (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). 1963. 7p.

A servomotor with transistorized amplifier was designed for the purpose of testing control circuits. The band width is up to 3 c/sec, but the system responds up to 10 c/sec. The motor starts to move with a minimum signal of 10 mv. The servomechanism is capable of delivering 400 mw. The operation is explained using block diagrams, X and the input circuit is given. The performance and operation of the amplifier is discussed. (J.S.R.)

479 (TID-19582) DEVELOPMENT LEADING TO AN IMPROVED DENSITOMETER FOR HELIUM GRAPHITE OR NITROGEN GRAPHITE FLOW STREAMS. Quarterly Report No. 189-18, February–April 1963. Donald H. Strobel (Badger Meter Mfg. Co., Milwaukee). Oct. 1, 1963. Contract AT(11-1)-1111. 9p.

An instrument is being developed for measuring the density of helium–graphite and/or nitrogen–graphite mixture flow streams. The instrument is a closed loop servo system using radioisotopes for the density-sensing transducers. The performance of the densitometer was evaluated using the Helium/Graphite test loop and found to be unsatisfactory. The vibrating reed modulators were found to be responsible for the drifting and poor repeatability, while the radiation detector was responsible for the poor sensitivity. The nonlinear unstable conditions of the modulators are described, and possible ways of eliminating them are considered. Redesign of the detector resulted in increased sensitivity and signal-to-noise ratio. The program for the proper handling of the radioisotopes in the densitometer is outlined. (D.L.C.)

480 NEW MILLIMETER WAVE DEVICE — BEAM-PLASMA AMPLIFIER. George A. Swartz (RCA Labs., Princeton, N. J.). Electronics, 36: 40-2(Nov. 8, 1963).

The beam-plasma amplifier was developed for the electromagnetic spectrum from 100 Bc out to laser frequencies. The need for radical new circuits and techniques to be used in this region is illustrated by waveguides and cavity resonators shrinking to the vanishing point for these wavelengths, and any component with wires is likely to have too much self-inductance and capacitance to be tolerated. The amplifier utilizes the penetration of a plasma by an electron beam. (R.E.U.)

481 MEASUREMENT OF ABSOLUTE RADIATION INTENSITIES IN THE VACUUM-ULTRAVIOLET REGION. Einar Hinnov and Fritz W. Hofmann (Princeton Univ., N. J.). J. Opt. Soc. Am., 53: 1259-65(Nov. 1963). (MATT-186)

A method for calibrating vacuum-ultraviolet monochromators for measurement of absolute radiation intensities is described. It is based on calculating the brightness of an optically thin spectral line in the far ultraviolet from the brightness of a visible line originating from the same upper level. A grazing incidence monochromator and a Seya–Namioka monochromator were calibrated at a number of wavelengths between 1640 and 231 Å, using line pairs of hydrogen and ionized helium. Light sources used to obtain these lines are described. Problems of measurement and sources of error, particularly in the case of hydrogenic spectra, are discussed. (auth)

482 EFFECTS OF HIGH-SPEED SECONDARY ELECTRONS ON THE PERFORMANCE OF HELIX-TYPE TRAVELING-WAVE TUBES. Richard Lewis Turner, Jr. Thesis, Seattle, Univ. of Washington, 1962, 102p.

The effects of the presence of a beam of high-speed secondary electrons on the operation of a traveling-wave tube are analyzed. Experimental results are set forth, which are in substantial agreement with the calculations. The beam of high-speed secondary electrons produced when the primary beam impinges on the collector can serve as a feedback mechanism in the traveling-wave

tube. Analysis is made of the manner in which the signal is introduced onto this beam and also of the manner in which the output of this beam is coupled to the main or forward-traveling amplification system of the tube. There are shown to be 3 principal effects of this secondary beam: A second-order fluctuation is superimposed on the usual variation of gain as the helix voltage is varied; the cross-modulation characteristics of the tube are materially altered, even to the extent of the production of "negative" cross modulation; and the output impedance of the tube is changed, particularly so when any discontinuities are present on the slow-wave structure. Experimental methods of observing these effects in an S-band, helix-type traveling-wave tube are described, and results are presented in a form that substantiates the theoretical predictions. (M.P.G.)

483 EFFICIENCY OF PARALLEL OPERATING SPARK DETECTORS. N. I. Rudnev, V. A. Suprunenko, E. D. Volkov, and E. A. Sukhomlin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 308-14(1963). (In Russian)

A spark detector was described, and its performance as a function of pulse power under a wide range of electrode potentials was analyzed. The detector operates with 100 ka currents at 1 to 40 kw with a delay less than 10^{-6} sec. (R.V.J.)

484 THE MEASUREMENT OF PHYSICAL EFFECTS FROM NUCLEAR EXPLOSIONS. Robert B. Vaile, Jr. (Stanford Research Inst., Menlo Park, Calif.). p.123-32 of "Experimental Techniques in Shock and Vibration." Will J. Worley, ed. New York, American Society of Mechanical Engineers, 1962.

The principles and design features of gages for measuring ground velocities and displacements produced by nuclear explosions are outlined. (T.F.H.)

485 INSTRUMENTATION AND DATA HANDLING SYSTEMS FOR SATELLITES. C. O. Bostrom (Johns Hopkins Univ., Silver Spring, Md.). 16p. (CONF-250-10).

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

The radiation detection, telemetering, and data processing systems used for analyzing cosmic electrons, protons, neutrons, alpha particles, and photons, as well as the Van Allen trapped radiation, are reviewed. The review is based on the experience gained with three satellites, viz. Injun I, Injun III, and TRAAC. (T.F.H.)

Radiation Detection

Refer also to abstract 862.

486 (AD-297107) IMPROVEMENTS OF RADIAC SET AN/PDR-58(XN-1). Final Development Report, May 1962–January 1963. (American Machine and Foundry Co., Alexandria, Va.). Contract NObsr-87484. 28p.

An experimental program was conducted to improve the neutron energy response of the neutron scintillation detector of the AN/PDR-58 (XN-1) Neutron Survey Meter. The final neutron detector developed very closely approximates the mrem/hr per unit neutron flux for neutron energies from 0.025 ev to 15 Mev as specified in NBS Handbook 63. In addition, the final detector has a much higher overall sensitivity. (auth)

487 (AFCRL-62-1105) PROPORTIONAL COUNTER SPECTROMETER FOR SOLAR X RAYS BETWEEN 1 AND 10 ANGSTROMS. Instrumentation for Geophysics and Astrophysics No. 23. Leon Heroux, James E. Manson, and Roger Smith (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Oct. 25, 1962. 24p. (AD-298952)

The construction and operation of a proportional counter spectrometer for measurements of solar x rays is described. The spectrometer was designed so that the detector and its associated circuitry could be mounted as auxiliary equipment on a telemetering monochromator that is flown in an Aerobee Hi rocket and pointed at the sun. The spectrometer analyzes solar radiation in five intervals of wavelength between about 0.8 and 10 Å. (auth)

488 (BNL-7375) AUTOMATIC BUBBLE DENSITY MEASUREMENT WITH THE HOUGH-POWELL SYSTEM. R. C. Strand, A. M. Thorndike, and N. W. Webre (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT-30-2-GEN-16. 17p.

A Hough-Powell fast analysis system (HPD) for bubble chamber photographs is described, as well as a method devised for automatic bubble density measurements with it. The HPD uses a mechanical flying spot with appropriate optical and electronic elements to reduce the photograph data to digital form. Results obtained for tracks in 900-Mev π^+ events are presented. The reproducibility of the measurements is currently of the same order of magnitude as the statistical error. (D.C.W.)

489 (EURAEC-287) SOLID STATE NEUTRON DETECTOR. Final Report No. 1, October 1, 1960–September 31, 1961. (Brussels. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 029-61-10-RDB. 8p.

The preparation of SiC single crystals and diodes was investigated, and the structural changes of SiC p-n junctions upon reactor irradiation were studied. The SiC diodes were found to be quite radiation resistant in comparison with Si diodes. The nature of defects produced in SiC crystals by neutrons were examined by electrical conductivity and Hall effect measurements. (D.C.W.)

490 (HASL-108) IONIZATION CHAMBERS FOR ENVIRONMENTAL RADIATION MEASUREMENTS. Arthur Shambon, Wayne M. Lowder, and William J. Condon (New York Operations Office. Health and Safety Lab., AEC). Feb. 1963. 42p.

The development of ionization chambers for precise dosimetric measurements of environmental gamma and cosmic radiation in the field is described. The design, calibration, and evaluation of 20-liter air ion chambers and high-pressure argon and nitrogen chambers are discussed in terms of the difficulties associated with field surveys of environmental radiation. (auth)

491 (HW-78872) PORTABLE RADIATION SURVEY INSTRUMENT. E. M. Sheen and W. G. Spear (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1963. Contract AT(45-1)-1350. 13p.

The instrument described features solid state circuitry, 50-hr operation without recharge of its Cd–Ni batteries, operation with several types of beta-gamma and alpha detectors, direct adaptability to continuous power line operation, satisfactory performance at −70 to 130°F, low unit cost, and three metered counting rate ranges. (D.C.W.)

492 (NAA-SR-Memo-8832) A CALIBRATION PROCEDURE FOR THE URANIUM PIN-HOLE CAMERA. M. A. Greenfield and R. L. Koontz (Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 12, 1963. Contract AT-11-1-GEN-8. 7p.

Calibration was performed in order to determine the resolution achievable with the camera, and to ascertain the adequacy of the features affecting the quality of the pin-hole image. The calibration procedure is described, along with a method to calibrate the image size. (P.C.H.)

493 (PAN-266) THE HIGH PRESSURE HELIUM–XENON GAS SCINTILLATION COUNTER AS A FAST NEUTRON ENERGY AND SPIN POLARIZATION ANALYSER. J. Szmider and J. Szymakowski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). June 1963. 14p.

A high-pressure helium-xenon gas scintillation counter was constructed. The counter is suitable for work at total pressures between 100 and 320 kG/cm^2. A general description of the counter and details of its construction are given. The counter was also used as a neutron scatterer for the determination of the degree of spin polarization of neutrons from the D(d,n)He^3 reaction. (auth)

494 (RT/FI(63)-26) DESIGN AND PERFORMANCES OF A SLOW NEUTRON CHOPPER. B. Antonini, N. Merzagora (Milan. Politecnico); and G. Pauli (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio Fisica e Calcolo Reattori, Ispra). Apr. 1963. 27p.

The electronic and mechanical features of a time-of-flight facility installed at the RC-1 reactor for neutron cross section measurements are described. The resolution and transmission of the slow chopper are discussed, as are experimental checks on the calibration of the time-of-flight scale and the resolution of the device. The results of neutron total cross section measurements for benzene at 0.001 to 0.1 ev are presented. (D.C.W.)

495 (ZFK-PHA-7) DER EINFLUSS DER WINKELAUFLÖSUNG EINES GAMMADETEKTORS AUF WINKELVERTEILUNGS- UND WINKELKORRELATIONS-MESSUNGEN. (The Influence of Angular Resolution of a Gamma Detector on Angular Distribution and Angular Correlation Measurements). Viswesvariah Malavalli and Frank Baldeweg (Germany. Zentralinstitut für Kernphysik, Dresden). Dec. 1962. 41p.

Correction factors to the angular-distribution and angular-correlation coefficients calculated for various crystal-source geometries on the Carl Zeiss Digital Computer ZRA 1 for cylindrical NaI(Tl) crystals are presented in graphs and tables. (auth)

496 SPACE RADIATION MONITORING SYSTEM. DePaul J. Corkhill. Aerospace Med., 34: 614-17(July 1963).

The requirements of a system to measure levels of all biologically significant ionizing radiation, necessary for planned animal and human space flight, are discussed. A breakdown of weights, volumes, and average power requirements for the elements of the system is tabulated. Other system features discussed in detail are: semiconductor design, digital techniques, data recording, and detectors. The proposed detector for charged particles and gamma rays and the neutron detector are illustrated. It is concluded that the space radiation problem is not as insurmountable as once assumed; the answer to space radiation monitoring probably was in the development of a totally solid state radiation detection system which would be more efficient, lighter, less bulky, and more rugged. Such a system is now being developed and is scheduled for delivery in 1963 under an Air Force contract that originated at the Aeromedical Field Laboratory, Holloman Air Force Base, New Mexico. (BBB)

497 ON THE RESULTS OF TESTS WITH THREE-ELECTRODE CHARGED-PARTICLE TRAPS IN THE SECOND AND IN THE OUTERMOST RADIATION BELTS OF THE CHARGED PARTICLES. K. I. Gringauz, S. M. Balandina, G. A. Bordovskii, and N. M. Shyutte. Iskusstv. Sputniki Zemli, Akad. Nauk SSSR, No. 15, 92-7(1963).

Three-electrode traps were irradiated with electrons of energies previously attributed to the soft electrons in the second and the outermost radiation belts surrounding the earth. The purpose of the experiment was to prove the contention that the absence of high negative currents in the traps during passage through the second radiation belt was not accidental and to evaluate the errors in determining the electron flows in the outermost belt. The electron flow formed by the electron gun was focused by means of a cylinder. Variation in cylinder voltage in relation to the plate made it possible to regulate the electron energy in the range from 150 ev to 40 kev. Control measurements of the value of the total current were made by means of a special probe. The degree of electron-flow focusing was checked by means of a luminescent screen. The trap was able to turn in relation to the direction of electron flow and its internal and external grid voltages were altered during the experiment. Measurements confirm that the coefficient of secondary-electron emission decreases with an increase in primary electrons. The negative collector current decreases in absolute value with an increase in the electron energy in the incident flow. At the same time, in an incident flow, variations in internal grid potential within the range of −150 to −200 v have no effect on the collector. (OTS)

498 ABSOLUTE REPRESENTATION OF THE ROENTGEN UNIT IN THE Co^{60} GAMMA-RAY ENERGY INTERVAL BY MEANS OF CAVITY IONIZATION CHAMBERS. A. Rakow and W. Will (Institut für Biophysik der Forschungsgemeinschaft der Naturwissenschaftlichen, Technischen und Medizinischen Institute der Deutsche Akademie der Wissenschaften, Berlin). Kernenergie, 6: 496-504(Sept. 1963). (In German)

A dosimetric comparison in the energy region of Co^{60} radiation showed that the information from various clinics and institutes of the DDR on dose measurements for irradiation with Co^{60} gamma radiation was obtained using measuring instruments of different kinds, which deviated from one another by up to 30%. Therefore cavity ionization chambers were built of graphite and aluminum, which make possible the absolute representation of roentgen units. The necessary corrections in dose determination with regard to electron slowing capacity, primary radiation weakening, scattered radiation additions, unsymmetricalness of the intensity over the active chamber volume, air density, and air moisture are described. An estimation of the errors appearing showed that these cavity ionization chambers make possible dose determinations with a maximum exactness of about 2%. A comparison with an earlier measurement of the power of a theratron-junior installation at the National Research Council of Canada gave a deviation of only 0.9%. (tr-auth)

499 RESULTS FOUND BY APPLYING A STABILIZING CIRCUIT FOR SCINTILLATION COUNTERS. H. Linemann and G. Nentwig (VEB Vakutronik WIB, Dresden). Kernenergie, 6: 504-6(Sept. 1963). (In German)

The change with time of the initial pulse height of a scintillation measuring apparatus can be kept small in the use of a simple apparatus if a suitable standard circuit is constructed. For the numerous published wirings, that given by Scherbatskoy was investigated. From that it was shown, that by regulation of the standard circuit by an effective pulse a satisfactory stabilization is achieved. On an additional, constant light-pulse source therefore a series of practical applications can be renounced. (tr-auth)

500 IONIZATION CHAMBERS FOR MEASURING AND CONTROL TECHNIQUES. F. Peschke, W. Frey, and G. Gabriel (VEB Vakutronik WIB, Dresden). Kernenergie, 6: 520-3(Sept. 1963). (In German)

Designs and uses of ionization chambers are described. (M.C.G.)

501 MEASUREMENT OF SCINTILLATION DETECTOR EFFICIENCY FOR FAST NEUTRONS. Andras Adam, Gabriella Palla, and Pal Quittner. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 253-60(1963). (In Hungarian)

The efficiency and energy dependence of a scintillation detector for fast neutrons were experimentally determined. The measured energy dependence is found to be in good agreement with the calculated curve. Neutrons of various energies were obtained by scattering the 14.7-Mev neutrons from the $T(d,n)He^4$ reaction on hydrogen. The neutron yield was determined from recoil alpha counts. (auth)

502 ON A STATISTICAL PROPERTY OF LOGARITHMIC RATEMETERS. Endre Vegh. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 261-8(1963). (In Hungarian)

Investigations are made on the use of logarithmic rate meters for the counting of periodically arriving pulses and of pulses obeying the Poisson law of distribution. A practical method for the calibration of logarithmic rate meters is described. (auth)

503 BF_3 PROPORTIONAL COUNTERS. Zoltan Madarasz. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 321-9(1963). (In Hungarian)

The BF_3 proportional counter types built for the counting of neutrons developed and built in the years from 1959 to 1962 are described and their characteristic data specified. (auth)

504 NON-LINEARITIES IN AMPLIFICATION OF SIGNALS FROM TIME-TO-PULSE HEIGHT CONVERTERS. Etele Debreczeny. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 331-42(1963). (In Hungarian)

The signals from a linear time-to-pulse height converter are distorted, their linearity impaired when passing through an amplifier. A mathematical relation is established between the converter and amplifier parameters and the relative value of non-linearity that permits the determination of the error for any given measuring setup. (auth)

505 TWO-CANAL RECORDER OF NUCLEAR RADIATION ON THE BASIS OF UNIVERSAL "TISS" RADIOMETER. V. S. Merkulov, E. E. Martynova, and V. A. Barynin. Med. Radiol., 8: No. 8, 66-71(Aug. 1963). (In Russian)

On the basis of the universal TISS radiometer, a two-channel recorder of nuclear radiations was developed. A detailed description is given of all the alterations and modifications introduced into the scheme of TISS radiometer. (P.C.H.)

506 AUTOMATIC FILM-BADGE READER IMPROVED. R. B. Purcell, H. McGary, D. Parker, P. Boren, and M. Wilhelmsen (Atomic Energy Commission, Idaho Falls, Idaho). Nucleonics, 21: No. 11, 66-8 (Nov. 1963).

An automatic film-density-reading system is described. Some fail-safe features of the machine and its data format are given. (R.E.U.)

507 RADIATION-SENSITIVE PAINT VERIFIES PRODUCT IRRADIATION. J. J. Farrell and R. L. Vale (United Kingdom Atomic Energy Authority, Wantage, Berks, Eng.). Nucleonics, 21: No. 11, 78-80; 82; 84-5 (Nov. 1963).

A radiation-sensitive paint was developed (NSA 17: 16475) as a detector to be used to verify irradiation of consumer goods. It furnishes proof of irradiation of every unit or package of product. The polymer-dye paint is placed on adhesive labels and undergoes a stable color change upon exposure. The color change is independent of dose and is, therefore, only a detector. The paint shows a response at a minimum of 2.5 Mrad. The mechanism of reaction is discussed. (R.E.U.)

508 ON THE CHEMICAL DOSIMETRY OF IONIZING RADIATION (2ND REPORT). Shigetoshi Antoku (Hiroshima Univ.). Proc. Inst. Nucl. Radiation Res. (Japan), No. 2, 1-9(1961).

Chlorinated hydrocarbons associated with pH indicator dyes were irradiated to measure radiation dose. The change change in H+ concentration due to irradiation decomposition of halogen compound was determined by means of optical density measurements. From the experimental results, the following conclusions were reached: In $CHCl_3$–fibromcresol purple mixtures (B.C.P.), the acid yield decreased with decreasing concentration. The reaction yield was about 13 μM/l/1000 r for saturated $CHCl_3$–B.C.P., and 12 μM/l/1000 r for saturated $CHCl_3$–phenol red (P. R.). Therefore, the decomposition of $CHCl_3$ is not greatly affected by the kind of pH indicator. The acid yield of chloral hydrate–B.C.P. rose gradually from 0.5 to 0.01 M and under 0.01 M it fell rapidly with the decrease in concentration. The x-ray decomposition of $CHCl_3$ was independent of dose rate within the range studied but C.H. was somewhat dependent on it. The G value was not affected significantly by the dye concentration. The proper dye concentration was found to be 1.0 ml stock solution of dye per 100 ml of dosimeter in both systems. Chloral hydrate solution spontaneously deteriorates slowly upon standing, but the deterioration is not noted in low concentration. $CHCl_3$ solution does not show such spontaneous decomposition. Therefore, for use as a dosimeter, the latter is more useful than the former. For use as a dosimeter solution, 7×10^{-2}M (saturated) for $CHCl_3$ and 0.01 M for chloral hydrate were found to give the desired properties. (auth)

509 MEASUREMENT OF THE ABSORBED DOSE IN IRRADIATED PATIENTS BY MEANS OF THERMOLUMINESCENCE DOSIMETERS. A. Morczek, K. Neumeister, G. Reichel, M. Frank, and L. Herforth (Strahleninstitut und der Strahlentherapeutischen Klinik der Medizinischen Akademie, Magdeburg, Ger. and Technische Universität, Dresden). Radiobiol. Radiotherap., 4: 491-8 (1963). (In German)

Starting from the necessity of measuring the radiation dose of smallest body volumes, LiF crystal dosimeters of smallest dimensions were used. The physico-technical properties of the dosimeters, especially their energy dependence, the possible uses as well as the experiences in the clinical dosimetry are reported. (auth)

510 SIMULTANEOUS DOSIMETRY BY MEANS OF THERMOLUMINESCENCE. G. Rauh and F. Struss (Martin-Luther-Universität, Halle-Wittenberg, Ger.). Radiobiol. Radiotherap., 4: 499-508(1963). (In German)

A simultaneous dose measurement with smallest detectors for medical use with therapeutic x ray and γ radiation doses is described, based on the method of thermoluminescence by means of the Lenard-phosphor $CaSO_4$–Mn which is melted down into glass tubes of 0.5 mm minimum outer diameter. The dose will be determined after irradiation by transforming the light intensity being released by heating the detector, by means of a photomultiplier into electrical current, the time behavior of which will be registered. The dose is proportional to the time integral of the

lighting intensity (sum of fluorescent light). The detectors are wavelength-dependent like bone-tissue and may be used as often as one likes. The good reproducibility of the method makes it suitable for special problems of research. (auth)

511 DOSIMETER FOR MIXED γ-NEUTRON RADIATION. V. I. Ivanov. Sb. Rabot po Nekotorym Voprosam Dozimetrii i Radiometr. Ionizir. Izluchenii, [No. 2], 121-4(1961).

A method for mixed γ-neutron dosimetry was tested on a model using a proportional counter filled with BF_3. An ordinary counter surrounded by a layer of paraffin for retarding n from a Po–Be source was used. Pulses caused by capture of thermal n were considerably greater than pulses caused by γ rays. Results of investigations made with a Po–Be n source and with Ra as the γ source showed that the proposed method is applicable for dosimetry. (Ref. Zh., Fiz. 1963)

512 MEASUREMENT ASSEMBLY FOR HIGH GAMMA FLUX. H. Rigaut and M. Dieval (Commissariat à l'Énergie Atomique, [Paris]). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 463-7(1963).

Equipment designed and constructed to permit high gamma flux survey and measurement is described. This instrument is an essential component of the high activity cells where remote handling, transformation, and examination of irradiated fuels or highly active radioisotopes are performed. The instrument can also be used in irradiation facilities and other nuclear installations such as reactors and accelerators. The detector is an air-filled low-volume unsaturated ionization chamber with a logarithmic measurement scale covering the range of 1 to 100,000 roentgens/hour. Particular attention was directed to the resolution of problems presented by contamination, standardization, and by connections between the probes and the measurement box. (auth)

513 ON THE POSSIBILITY OF APPLYING A SCINTILLATION METHOD FOR RECORDING SMALL ENERGY IONS. A. B. Rastrepin and I. M. Zolototrubov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 328-34(1963). (In Russian)

Scintillation counters were used for recording 1 to 20 kev ions under continuous operation with a constant anode voltage and with a single-pulse supply. Selected photomultipliers were capable of measuring ion currents to 10^{-15} amp. The lower limit for ion detection is limited by photomultiplier dark current. The suggested method is useful for measuring both continuous flux and separate ion clusters. (R.V.J.)

514 COUNT RATE METER [Q-2191A] (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1048)

This package contains 6 drawings. The instrument is used for area monitoring. It features a built-in amplifier, a regulated high voltage supply for the detector, and long time stability. The circuitry is simple and the packaging compact. The instrument may be used with a G-M tube or any detector requiring positive high voltage, having a current drain less than 50 μa, and producing negative pulses with amplitudes between 0.2 and 50 v. The power requirements are 115 v a-c, 0.40 amps, and 44 watts. (F.S.)

ISOTOPE TECHNOLOGY

General

515 (NP-13197) SINTERIZACIÓN DE DIÓXIDO DE URANIO DE PRODUCCIÓN NACIONAL. Informe No. 78. (Sintering Uranium Dioxide of Domestic Production). Report No. 78. Antonio J. Carrea (Argentina. Comisión Nacional de Énergia Atómica, Buenos Aires). 1963. 25p.

After a brief indication of the uranium–oxygen equilibrium and the methods for the preparation of UO_2, the sintering of UO_2 is considered. The effects of various sintering atmospheres on the properties of the product are discussed and tabulated. The method used for the processing of domestic ores for the preparation of UO_2 and the fabrication of the sintered UO_2 are described. The properties of the product obtained are illustrated graphically. (J.S.R.)

516 (RAI-202) THE DEVELOPMENT OF LARGE BETA RADIATION SOURCES AND THEIR APPLICATIONS. Jacques J. Weinstock, Yael Miron, and P. Murali Krishna (Radiation Applications Inc., Long Island City, N. Y.). July 1963. Contract AT(30-1)-2186. 140p.

An extensive research and development program produced vitreous enamel formulations suitable for the fabrication of large planar beta radiation sources using promethium-147, cerium-144, or strontium-90 as the active component. The physical and chemical properties of these enamels were characterized, and actual source dosimetry patterns were established for Pm^{147} and Ce^{144} sources. A parallel study developed an attractive radiation-induced graft polymerization process for modifying the properties of polypropylene films and fabrics which is ideally suited for the use of large beta sources. Over 60 different enamel formulations were prepared and evaluated with respect to coating (enameling) characteristics, resistance to attack by various solvents and aqueous solutions, and resistance to thermal and mechanical shock. The best formulations developed contain 24 weight percent of the active component (SrO, CeO_2, or Pm_2O_3) 51% SiO_2, and varying amounts of 9 other ingredients. They are more resistant to chemical attack than pyrex glass, and they can withstand considerable thermal and mechanical shocks (repeated quenches at temperature differences of over 600°F and repeated point impacts of over 10 inch-pounds). These enamels allow the fabrication of beta sources containing up to 5 curies per square centimeter of Pm^{147} in a 4-mil thick coating, up to 5 C/cm^2 of Ce^{144} in an 8-mil coating, and up to 1 C/cm^2 of Sr^{90} in an 8-mil coating. Such sources will deliver surface and near surface dose rates in the range of 1 to 10 megarads per hour. Actual dosimetry patterns are presented for enameled Ce^{144} and Pm^{147} sources containing approximately 0.1 millicurie per square centimeter. These dosimetry measurements are compared with theoretical calculations and show generally good agreement. Since isotopic beta sources can be fabricated so as to deliver uniform dose rates over large areas, the study of potential beta source applications concentrated on the modification of the properties of various plastic films and synthetic fabrics by means of radiation-induced graft polymerization. A number of systems were experimentally screened, and a single system—a copolymer methacrylic acid-styrene graft on polypropylene—was investigated in some detail. The effects of a number of process variables are defined (e.g., comonomer composition, total dose, dose rate, pretreatments, etc.), and properties of the resulting grafted samples are given. Excellent dyeability of grafted polypropylene fabric was demonstrated. (auth)

517 CATALOGUE OF RADIOISOTOPES, RADIOACTIVE PREPARATIONS, SPECIAL PURPOSE SOURCES, SERVICE IRRADIATIONS, [AND] SPECIAL SERVICES. (Australia. Atomic Energy Commission). June 1962. 99p. Free(Australian AEC).

Information is presented on the range of radioisotopes and sources being produced in Australia. The packing and transport of radioisotopes are described. Specifications and prices are presented for unprocessed and processed radioisotopes. Radiography sources and Co^{60} sources are also described. The irradiation, activation, and tritiation services and the advisory and consulting service are discussed. (D.L.C.)

Industrial Applications

518 (IITRI-1209-9) STUDY OF THE CAPABILITY OF ISOTOPIC SOURCE OF SECONDARY RADIATION. James J. Ezop (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Feb. 11, 1963. Contract AT(11-1)-578. 58p.

Studies were made to determine the optimum characteristics of beta-excited x-ray source designs, which, when coupled with the latest detection systems, would show the practical uses of such isotopic x-ray sources in such fields as medical radiography, missile and airplane inspection, and other non-destructive testing problems. A 250 C Promethium-147 source was fabricated into a pellet 7 mm in diameter by 2 mm thick. The photon output spectrum of the source was relatively monoenergetic peaking at 40 kev with a flux of $\sim 5.5 \times 10^5$ photons (40 kev)/sec/cm^2 at one foot from the source. Studies on medical samples and representative low-Z materials were conducted using the experimental Pm^{147} source in conjunction with standard x-ray films with intensifier screens, Polaroid x-ray films, and image intensifier systems. The results indicated that the photon flux was too small for satisfactory results using current image intensifier systems (laboratory systems now under development may provide the necessary gain to allow usage of low level sources), but radiographic x-ray films with one minute or less exposure times showed sufficient detail to determine gross defects such as bone fractures, foreign bodies lodged tissue, voids in aluminum alloy castings, defects in potted electronic circuitry etc. It was concluded that beta-excited x-ray sources would be useful nondestructive testing devices complementing standard x-ray sources since their small size and complete portability characteristics make them attractive for field tests and geometric situations where use of standard x-ray machines is impossible or impractical. (auth)

519 (TID-19366) DEVELOPMENT OF KRYPTON 85 AS A UNIVERSAL TRACER. INITIATION OF PHASE III. AREAS OF APPLICATION. Report covering period April 1–October 31, 1962. David Chleck, Richard Maehl, and Orlando Cucchiara (Parametrics, Inc., Waltham, Mass.). Nov. 1, 1962. Contract AT(30-1)-2757. 90p.

Solid sources containing krypton-85 (kryptonates) were prepared by diffusion at temperatures to 650°C and pressures greater than 5000 psi. A greater variety of types of solids were kryptonated. Every solid tested has col-

lected some krypton and retained some fraction of the gas with time. An optimum temperature of 550°C for the absorption of krypton by aluminum was found. For copper the logarithmic temperature dependency was found to extend to at least 600°C. With increased pressures no evidence of saturation has yet been found. The kryptonates were found to be an exceptional analytical tool for the determination of gaseous species. Oxygen concentrations spanning ten orders of magnitude (10^{-5} to 10^{5} ppm) can easily be ascertained with kryptonated copper. Analytical reactions of various kryptonates with ozone, hydrogen, sulfide, sulfur dioxide, and water vapor were also demonstrated. The kryptonates also afforded an excellent means of studying the kinetics and mechanisms of the reactions. Reactions of hydrochloric acid with metal kryptonates were followed demonstrating the use of kryptonates in carrying out analyses in solution. (auth)

520 EFFECTS OF SUBSTERILIZATION DOSES OF Co^{60} GAMMA RADIATION ON THE COLD-STORAGE LIFE EXTENSION OF SHUCKED SOFT-SHELLED CLAMS AND HADDOCK FILLETS. E. B. Masurovsky, S. A. Goldblith, and J. T. R. Nickerson (Massachusetts Inst. of Tech., Cambridge). Appl. Microbiol., 11: 220-8(May 1963).

Data are presented on the total numbers of aerobic facultative and obligately anaerobic microorganisms obtained from two commercially important sea foods before and at various periods of time after irradiation and storage at 0 and 6°C. Haddock fillets and shucked soft-shelled clams received doses of from 50000 to 800000 rad of Co^{60} γ rays. Haddock fillets could be maintained in good condition at refrigeration temperatures above freezing for about one week at 6°C, and ~2 weeks at 0°C, when treated with from 50000 to 150000 rad, and in the dose range from 200000 to 350000 rad, the storage life could be extended up to two weeks at 6° and three weeks at 0°C. Treatments in the dose range from 400000 to 500000 rad deferred spoilage for about one month, and doses of 550000 to 650000 rad up to ~1.5 months. At the high substerilization doses of 700000 to 800000 rad, haddock fillets could be held from two to three months in refrigerated storage before becoming unfit for marketing and consumption. Shucked soft-shelled clams could be held for ~2.5 weeks at 0°C and 12 days at 6°C, when given low substerilization doses of 50000 to 150000 rad. At doses of from 200000 to 350000 rad, the clams could be preserved effectively up to three weeks at 0 or 6°C, and six weeks at these temperatures with doses of about 450000 rad. With treatments of 500000 to 600000 rad, the storage life could be extended for two months, and at doses of 650000 to 800000 rad they remained in a good state of preservation for up to three months at 0 to 6°C. Thus, shucked soft-shelled clams may be maintained for significantly longer periods in refrigerated storage than haddock fillets when the same radiation treatments are applied. Clostridia levels in both products were relatively low initially and were reduced significantly by the doses studied. Moreover, those clostridia that survived the radiation treatments remained at safe low levels during the various periods in refrigerated storage. From the public health, as well as commercial standpoint, these results illustrate the feasibility of preservation of seafood by ionizing radiation. (BBB)

521 CHANGES IN THE MICROFLORA OF HADDOCK FILLETS AND SHUCKED SOFT-SHELLED CLAMS AFTER IRRADIATION WITH Co^{60} GAMMA RAYS AND STORAGE TO 0°C AND 6°C. E. B. Masurovsky, J. S. Voss, and S. A. Goldblith (Massachusetts Inst. of Tech., Cambridge). Appl. Microbiol., 11: 229-34(May 1963).

Microbiologic analyses were made on haddock fillets and shucked soft-shelled clams before and after treatment with doses of from 50000 to 800000 rad of Co^{60} γ rays. A decided change occurred in the constitution of the microbial populations of both products: from a mixed gram-negative-gram-positive flora to a predominantly gram-positive flora immediately after irradiation. The majority of these surviving microorganisms were micrococci, spore-forming bacilli, yeasts, molds, and actinomyces. During storage at refrigeration temperatures above freezing, the microflora changed from the more radioresistant gram-positive species to the more prolific gram-negative psychrophilic species that flourish at low temperatures. Micrococci and gram-positive rods declined somewhat during the rise of the actively proteolytic-lipolytic pseudomonads and related species, but still remained at high enough levels to contribute significantly to the spoilage observed at different times in storage. The eventual spoilage of haddock fillets was characterized by discoloration with water-soluble yellow, green, and red bacterial pigments; degradation of the tissue, by proteolytic and other microbial enzymes; and formation of volatile compounds that smelled putrid, rancid, and generally foul and pungent. Shucked soft-shelled clams displayed a different spoilage pattern, changing to a gelatinous mass with stale, acrid, putrid, sulfurous odor. These differences are attributable to the varied biochemical nature of the tissues involved, the Eh potential within the tissues, the time sequence of microfloral change, and the species and types of microorganisms associated with each product. Staphylococci were present in small numbers, but did not appear to be species of public health significance. Gram-negative enteric rods were also encountered, but were considered to be of doubtful public health importance. (BBB)

522 GAMMA IRRADIATION OF SALMONELLA SPECIES IN FROZEN WHOLE EGG. A. G. Comer, G. W. Anderson, and E. H. Garrard (Ontario Agricultural Coll., Guelph). Can. J. Microbiol., 9: 321-7(June 1963).

A study was undertaken to establish the survival pattern of 18 Salmonella species in frozen whole egg exposed to γ radiation from a Co^{60} source as part of a program to investigate the possibilities of using radiation for the destruction of micro-organisms in foods. A definite variation in sensitivity to radiation was found among these 18 species commonly occurring in frozen egg. The dose levels, applied at a dose rate of 0.491 Mrad/hr, required for a 10^{7}-fold reduction of these species ranged from 0.36 to 0.54 Mrad. Variation in sensitivity to radiation was also detected with three cultures of S. pullorum that appeared similar except in origin. Variation in sensitivity within all species of Salmonella studied apparently indicates that no one species can be considered most resistant. These studies reveal that a level of 0.54 Mrad of γ radiation would reduce the salmonellae to a safe level in frozen egg. However, this is based on the supposition that 10^{5} cells is a reasonable number to consider necessary for the initiation of salmonellosis. The most heavily contaminated frozen egg melange examined contained $\sim 2 \times 10^{5}$ cells of salmonellae/ml. Of these, any process giving a 10^{7}-fold reduction would leave only 2×10^{-2} cells/ml, i.e., 2 cells/100 ml or about 10 cells per lb. Apparently it would be necessary to consume several tons of uncooked melange to obtain an infective dose and therefore the 10^{7}-fold reduction is adequate from the viewpoint of the public health hazard. Although off-flavors develop in frozen whole egg irradiated with 0.5 Mrad, they disappear on storage and the irradiated product was found acceptable for commercial use. Thus

irradiation of frozen whole egg melange with 0.54 Mrad would not be expected to markedly increase the unfavorable alterations in the product, indicating that γ radiation possesses a distinct potential for removing Salmonella from frozen whole egg melange. (BBB)

523 CHANGES IN QUALITY AND COMPOSITION PRODUCED IN WINE BY COBALT-60 GAMMA IRRADIATION. V. L. Singleton (Univ. of California, Davis). Food Technol., 17: 112-15(June 1963).

Glass-bottled red port, white port, dry red table wine, and dry white table wine purged with nitrogen and air-saturated dry sherry material were irradiated with 100,000, 500,000, and 1,000,000 rad γ radiation. Analyses and sensory evaluation showed considerable changes after irradiation. The bottle glass changed from colorless to greenish-brown. The wines were under a small positive pressure when opened, both white and red wines were bleached, and odor and flavor were changed. Analytical results showed no changes in extract, ethanol, volatile esters, or volatile acid, but a slight increase in pH and decrease in total acidity upon irradiation. Changes in spectral absorption were great; absorbance diminished at every wavelength, but not proportionately. All untreated wines showed a maximum at 265 to 85 mμ and a shoulder at about 320 mμ, and the red wines the typical maximum near 520 mμ, which was much decreased by irradiation. The absorbance at 320 mμ was greatly decreased and the shoulder disappeared, leaving only the residual absorption from the more intense but less affected peak at 265 to 85 mμ (absorption at these wavelengths is attributed largely to their content of flavonoid, polyphenolic substances). No appreciable change in the tannin (total polyphenolic) content was seen, but paper chromatographic studies showed definite qualitative and quantitative changes in polyphenols The oxidation-reduction potential was greatly lowered by irradiation, and volatile substances reacting as aldehydes were produced in considerable amounts, confirming that definite, selective, and specific compositional changes are produced in wine by γ irradiation at feasible dose levels. With wines flavor-rated by experienced judges with reference to standard wine types, large changes were produced by 500,000 and 1,000,000 rad. Grape aroma rating was significantly decreased in all cases by the higher levels of irradiation. A radiation-induced flavor seemed similar, regardless of the type of wine irradiated. Descriptive terms suggested by the panel for this flavor included cheesy, fishy, perfumy, leathery, sulfurish, fatty, metallic, aged-European-wine-like, whey-like, burned, mushroomy, and fruity. However, comments were favorable on the flavor and odor induced by high levels of radiation by 5 of the 14 panelists. The possibility of favorably influencing the quality of standard types of wine by irradiation near or below 100,000 rad seems worthy of further study, it was concluded. (BBB)

524 EFFECT OF METHIONINE AND AGE OF RAT ON THE OCCURRENCE OF HEMORRHAGIC DIATHESIS IN RATS FED A RATION CONTAINING IRRADIATED BEEF. Om P. Malhotra and E. F. Reber (Univ. of Illinois, Urbana). J. Nutr., 80: 85-90(May 1963).

The possible role of methionine in the bleeding noted previously in rats fed γ irradiated beef was studied. In weanling Sprague-Dawley rats fed 5.58-Mrad irradiated beef, a significant number of deaths occurred. Addition to the diet of 0.2 to 2.74% methionine reduced the mortality rate linearly. The prothrombin rate of rats fed an irradiated-beef ration was lower than that for rats fed nonirradiated beef, and it increased when the ration was supplemented with methionine. Growth was depressed by dietary methionine. Some adult rats died of internal hemorrhages when fed a ration containing nonirradiated beef, indicating adults were more susceptible than weanling rats to hemorrhagic diathesis. Feeding irradiated beef increased the mortality, but it was decreased by supplemental methionine. Methionine dietary content required to prevent hemorrhagic disease in adult rats fed nonirradiated-beef diet was less than that of rats fed irradiated beef. There was a linear decrease of body wt gain with increasing supplemental methionine, which was less for rats fed nonirradiated beef than for those fed irradiated-beef rations. Despite the effect of methionine in reducing the mortality rate, the occurrence of hemorrhage and subsequent death in rats did not take place primarily because of the destruction of methionine in beef by ionizing radiation, as was demonstrated by increasing the available methionine to 0.55%, above the amount available in the nonirradiated-beef diet, without beneficial effect. Previously, no appreciable change was found in methionine in irradiated beef. Whether the metabolism of sulfur-containing amino acids in rats fed an irradiated-beef ration was altered was not determined. It is suggested, as a possible explanation for its protective effect, that methionine increased Factor VII which was then converted to prothrombin in rats receiving irradiated beef. Another explanation of its protective effect could be that it depressed growth and hence the vitamin K requirement. However, only 1.14% supplemental DL-methionine prevented death due to hemorrhages in adult rats fed nonirradiated beef and had no detrimental effect on body wt gains. (BBB)

525 GAMMA RADIATION OF EYE MEDICAMENTS. A. J. Ogg (Salisbury General Hospital, Eng.). Lancet, 2: 96(July 13, 1963).

The use of x rays to sterilize ophthalmological pharmaceutical preparations is described, particularly penicillin and fluorescein drops. The method used with penicillin is to place a tablet (1500 units) in a small vial which is closed with a cork and attached with Sellotape to a 5-ml eye-drop bottle containing 3 ml of normal saline. The bottles were sealed in two polythene envelopes and irradiated at the Wantage Research Lab (AERE) at a dose of 2.5 Mrad. The bags are then stored in a refrigerator at 4°C. When required for operation, the outer bag is opened with sterile scissors, and the contents tipped onto the surface of the sterile instrument tray. The dropper bulb is filled with saline and introduced into the vial, thereby dissolving the tablet of penicillin. All irradiated preparations were found to be absolutely sterile and fully potent. In the case of fluorescein, 1-in. lengths of gauge 2-intraarterial polythene tubes are filled with the dye from a syringe, and the ends of the tube sealed in a flame. Several hundreds of tubes are irradiated in a single container, and when required, one end of the tube is cut off and a drop squeezed out into the conjunctival sac. (BBB)

526 IMPROVING THE ACCURACY OF DOSIMETRIC CHARACTERISTICS OF Ce^{144}, Pr^{144}, AND Kr^{85}. V. V. Ovechkin and D. V. Ovechkin. Sb. Rabot po Nekotorym Voprosam Dozimetrii i Radiometrii Ionizir. Izluchenii, [No. 2], 50-1(1961).

Results are given of calculation of γ constants for Ce^{144}, Pr^{144}, and Kr^{85}, made on the basis of more precise experimental data on the corresponding γ-quanta yields. The γ constant was determined by the formula: $K\gamma = 1.54 \times 10^5 \Sigma h\nu_i \cdot \gamma_i \cdot n_i$ r/hr-mc, where $h\nu_i$ is the γ-quantum energy in Mev; γ_i is the coefficient of true γ absorption in air in cm^{-1}; n_i is the yield of γ quanta of a given energy per

decay. The accuracy of determination of γ-quanta yield of Ce^{144} and Pr^{144} with energies of 80, 134, 700, 1490, and 2180 kev was improved by using a face-end β-counter and a scintillation γ spectrometer. (Ref. Zh., Fiz. 1963)

527 THE GROWTH, REPRODUCTION, LONGEVITY, AND HISTOPATHOLOGY OF RATS FED GAMMA-IRRADIATED PEACHES. Ian J. Tinsley, Jesse F. Bone, and Edward C. Bubl (Oregon State Univ., Corvallis). Toxicol. Appl. Pharmacol., 5: 464-77(July 1963).

Wistar rats were fed canned peaches irradiated to 5.58 and 2.79 Mrad, or unirradiated peaches, incorporated into three separate rations and fed to three generations of rats. The three generations were fed for 14 weeks to determine growth rate and thereafter were carried through two pregnancies. The first-generation animals were then maintained for a max of two yr for longevity studies. For the first-generation animals, irradiation did not result in any significant differences in growth rate, but there was a tendency toward lower growth rates in animals in successive generations. Statistical analyses of food efficiency indicated a significant effect due to irradiated ration with a significant sex and generation interaction. In the parent and F_1 generation higher food efficiencies were observed with the irradiated peach rations, but in the F_2 generation food intakes were comparable to the three rations and no differences in food efficiency were apparent. No differences in reproduction and lactation performance were observed which could be attributed to irradiation. Animals raised on the 2.79-Mrad ration started dying earlier than those on the other two rations and this was associated with a higher incidence of chronic nodular pneumonia. Between 400 and 700 days of age there was essentially no difference in mortality rates among animals raised on the three rations. No differences in hematologic findings could be attributed to the irradiation variable, and no significant changes in pathology were induced by ingestion of the irradiated peach rations other than a higher incidence of chronic progressive nodular pneumonia in females raised on the 2.79-Mrad ration. An increase in kidney degeneration also observed in these females was probably associated with the higher incidence of pneumonia. The incidence of these conditions in females raised on the 5.58-Mrad ration was comparable to that observed in females raised on the control ration. Hence the high incidence of pneumonia in females raised on the 2.79-Mrad ration probably is unrelated to the irradiated diet. (BBB)

528 RESULTS OF VACCINATION WITH LUNGWORM (ORAL) VACCINE IN THE FIELD IN 1960. A. M. R. Nelson, Bruce V. Jones, and R. Peacock (Allen and Hanburys Ltd., Ware, Eng.). Vet. Record, 73: 153(Feb. 18, 1961).

Additional studies showing the effectiveness of an irradiated lungworm vaccine, used for prevention of husk in cattle, are reported. There was a low incidence of the disease on farms where the vaccine had been employed. Thus, in 1960 it is estimated that the vaccine was used on ~8000 farms and on only 28 (0.35%) was any evidence of parasitic bronchitis observed in vaccinated calves. The relatively few negative results may be attributed to the fact that vaccinated and susceptible animals were admitted to the same pasture, thus introducing a risk of heavy pasture contamination, since susceptible animals may build up a massive larval population very quickly if climatic conditions are right. If vaccinated calves are exposed to such a massive challenge, their immunity may be overcome. Where pasture contamination was not excessive, however, results from grazing vaccinated and susceptible stock together were satisfactory. When all calves were vaccinated, there was little risk of a build-up of larval contamination of the pasture. It is concluded that the extremely low incidence of reported cases of husk among vaccinated animals amply demonstrated the efficacy of the irradiated vaccine. (BBB)

Power Application

529 (NASA-TN-D-2070) A NUMERICAL ANALYSIS OF DIRECT NUCLEAR ELECTROGENERATOR CELLS THAT USE CERIUM 144 BETA-EMITTING RADIOISOTOPE SOURCES. Allan J. Cohen (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Dec. 1963. 56p.

An analysis of a radioisotope electric cell that uses the beta emitter, cerium-144, was undertaken. The analysis, which relies on formats set forth for fission electric cells, takes into account the pertinent physical constraints in a more accurate manner than has been done previously. Results from the analysis are presented in tables and as representative plots. Comparisons between accurate and approximate solutions are also included. (auth)

Separation and Production

530 A METHOD FOR THE DETERMINATION OF ELECTROLYTIC HYDROGEN–TRITIUM SEPARATION FACTORS. J. O'M. Bockris, S. Srinivasan, and M. A. Z. Devanathan (Univ. of Pennsylvania, Philadelphia). J. Electroanal. Chem., 6: 205-10(Sept. 1963).

A new method for the determination of electrolytic H/T separation factors is described. Copper or mercury was used as the test electrode. Vacuum systems, used in previous methods, were eliminated. Instead, helium was used to carry the electrolytically evolved gases (H_2 and HT) into an oxidation train and also to carry the resulting water over into a collection system, whereafter the activity of the tritium was measured. The method has an accuracy of ±6%. (P.C.H.)

531 ENRICHMENT OF OXYGEN-18 BY THE CHEMICAL EXCHANGE OF NITRIC OXIDE WITH NITRIC ACID SOLUTIONS. S. C. Saxena and T. I. Taylor (Columbia Univ., New York). J. Phys. Chem., 66: 1480-7(Aug. 1962).

The rapid exchange of O^{18} between nitric oxide and nitric acid solutions occurs with a single stage enrichment factor of 1.020 ± 0.002 in approximate agreement with calculations from spectroscopic data. Since O^{18} concentrates in the gas phase, the use of the system required the conversion of nitric oxide to water and nitric acid. This was accomplished by partial decomposition of the nitric oxide in an arc, and reaction of the remainder with hydrogen to form water. The water extracted NO_2 from the gas stream to form nitric acid of the desired concentration. Some of the characteristics of the exchange reaction were investigated during the operation of exchange columns for the concentration of O^{18}. For 8 M nitric acid, the height equivalent to a theoretical plate (H.E.T.P.) increases approximately linearly with flow rates above 60 mg atoms of O/min-cm². At 25° and a flow rate of 85 mg atoms of O/min-cm², the maximum over-all separation was obtained for 6 M HNO_3. Although the rate of the exchange reaction increases with increasing acid concentration, the value of $(\alpha-1)$ decreases so that $(\alpha-1)$/H.E.T.P. is maximum for 6 M HNO_3. The over-all separation was not greatly affected when the temperature was increased from 25 to 60°, indicating that the product of the transfer coefficient and $(\alpha-1)$ is approximately constant. With a decrease in temperature, the decrease in the transfer coefficient was not compensated by an increase in

($\alpha-1$), so that the over-all separation decreased with the temperature was lowered to 0°. Cohen's theoretical equations for the increase in isotope concentration with time were used to analyze the operation of the exchange column and to determine the ratio of hold-up at the reflux end to the hold-up in the column. The optimum operating conditions for the system were selected and a comparison was made with other methods of concentrating O^{18}. The exchange system described appears to be somewhat more favorable than the distillation of water, but not as promising as the low temperature distillation of nitric oxide. (auth)

532 PLANT SCALE PRODUCTION OF CARRIER-FREE P^{32}. R. Muenze, L. Baraniak, G. Reinhard, and W. Leuschke (Zentralinstitut für Kernphysik, Bereich Radiochemie, Rossendorf, Ger.). Kernenergie, 6: 489-93(Sept. 1963). (In German)

The construction and the manner of operation of equipment for production of carrier-free P^{32} solutions are described. By liquid-liquid extraction the isolation from sulfur was obtained. For further purification of the solution distillation and ion-exchange steps were added. The end product was investigated for gamma-emitting constituents and radioactive S^{35}. The radiochemical determination of the individual oxy-acids of the phosphorus followed after paper-chromatographic separation. (tr-auth)

MATHEMATICS AND COMPUTERS

Refer also to abstract 2.

533 (HW-SA-3173) FUNDAMENTAL METHODS OF DETECTING BIAS. C. A. Bennett (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Aug. 28, 1963]. Contract AT(45-1)-1350. 9p. (CONF-160-4)

From Annual Atomic Energy Commission Contractors Meeting, Nuclear Materials Management, Idaho Falls, Idaho, Oct. 1963.

The types of bias that are encountered in measurement problems are discussed, along with some basic statistical procedures for detecting and estimating these systematic deviations or fluctuations. (D.C.W.)

534 (JINR-P-1317) KVADRATURNYE FORMULY DLYA SINGULYARNYKH INTEGRALOV. (Quadrature Formula for Singular Integrals). A. A. Konneichuk (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 13p.

Quadrature formulas of high algebraic precision are obtained for singular integrals. The formulas are analogous to the Gaussian formulas for the usual integrals. The technique for obtaining the formulas is general and may be applied for an arbitrary asymptotic behavior of the integrand. The formulas may be employed for the numerical solution of the singular integral equations, involving the equations describing the elementary particle interaction. (auth)

535 (JINR-P-1346) IDEOGRAMMA. (Ideogram). M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 11p.

The limiting properties of the ideogram for an infinitely large number of measurements are treated, as well as some fluctuation properties essential for a finite number of measurements. (auth)

536 (JÜL-126-MA) EIN EXISTENZBEWEIS FUR DIE BOLTZMANN-VLASOV-GLEICHUNG IM EINDIMENSIONALEN FALL. (An Existence Proof for the Boltzmann-Vlasov Equation in the One-Dimensional Case). Juergen Batt (Kernforschungsanlage. Institut fur Mathematik, Jülich, Germany). July 1963. 21p.

The Boltzmann-Vlasov equation, generalization of the problem, definitions, assumptions, auxiliary statements and proofs, and conclusions are discussed. (M.C.G.)

537 (NOLTR-62-193) THE EXISTENCE AND CALCULATION OF SOLUTIONS OF CERTAIN INTEGRO-DIFFERENTIAL EQUATIONS IN SEVERAL DIMENSIONS. A. Douglis (Naval Ordnance Lab., White Oak, Md.). Dec. 4, 1962. 59p. (AD-297403)

Boundary and initial value problems are solved for linear integro-differential equations, in several dimensions, of a type including linearized forms of Boltzmann's equation. The methods of solution are based on finite differences and are thus suitable for calculation. (auth)

538 SOME INTEGRALS AND EXPANSIONS RELATED TO THE HYPERGEOMETRIC FUNCTIONS F_1 AND Φ_2 IN TWO VARIABLES. Bengt Nagel. Arkiv Fysik, 24: 479-93(1963).

A three-dimensional integral occurring in the theory of the atomic photoeffect is evaluated in terms of the special case of a hypergeometric Appell function F_1 where the second and third parameters are equal. From the derivation, an expression of a one-dimensional integral involving a Bessel function as a corresponding confluent function Φ_2 is also obtained. Expansions of the F_1 function, useful for the numerical calculation of this function for physically interesting values of the variables, are derived. (auth)

539 ALTERNATING DIRECTION ITERATION METHODS FOR n SPACE VARIABLES. J. Douglas, Jr., R. B. Kellogg, and R. S. Varga (Rice Univ., Houston, Tex.; Bettis Atomic Power Lab., Pittsburgh; and Case Inst. of Tech., Cleveland). Math. Computation, 17: 279-82(July 1963). (WAPD-T-1590)

The iterative solution of the system of linear equations $(X_1 + X_2 + \cdots + X_n)z = f$, $n \geq 2$, where each X_j, $1 \leq j \leq n$, is a Hermitian and positive $N \times N$ matrix, is developed. (C.E.S.)

540 ON A NONLINEAR DIFFERENTIAL EQUATION ARISING IN NUCLEAR PHYSICS. Zeev Nehari (Carnegie Inst. of Tech., Pittsburgh). Proc. Roy. Irish Acad., Sect. A, 62: 117-35(Mar. 1963).

A proof is presented for the existence (but not uniqueness) of a solution for the differential equation $d^2x/dt^2 + (2/t)dx/dt - x + x^k = 0$, where $1 < k \leq 4$. The solution whose existence is proved is found to be continuous and positive for all t such that $0 \leq t < \infty$, and to approach 0 as $t \to \infty$. In this differential equation, t represents the distance from the origin of coordinates, and x any dependent variable. (T.F.H.)

METALS, CERAMICS, AND OTHER MATERIALS

General

541 (AD-419549) STUDY OF DUCTILE COATINGS FOR THE OXIDATION PROTECTION OF COLUMBIUM & MOLYBDENUM ALLOYS. First BiMonthly Progress Report, July 1, 1963 to August 31, 1963. (Metals and Controls Inc., Attleboro, Mass.). Sept. 30, 1963. Contract NOw 63-0706-C. 17p.

Present day oxidation resistant coatings for niobium and molybdenum base alloys are deficient in ductility. Feasibility of developing ductile coatings for service to 3000°F is being explored, initially based on the use of platinum metals. Development of suitable diffusion barriers is required if platinum metals are to be successful. Literature review of the performance of present day coatings and platinum metals is summarized. Review of diffusion barrier literature has begun. Equipment for screening oxidation tests is described. A testing and evaluation program to produce and screen potentially useful composites is presented. (auth)

542 (BMI-X-10061) DEVELOPMENT OF URANIUM MONONITRIDE. Quarterly Progress Report for July–September 1963. Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 22p. (EURAEC-845)

Uranium mononitride was fabricated by both powder and melting techniques. The probable source of the high oxygen content in uranium mononitride fabricated by powder techniques was traced to the powder preparation process. Tentative pressure-temperature diagrams for the uranium-nitrogen system were constructed. A solid solution was found between U_2N_3 and UN_2. Stoichiometric UN_2 exists only at very high pressures. Several types of UN, prepared by various fabrication techniques, are now being irradiated. The compatibility of UN with aluminum, Zircaloy-2, and type 304 stainless steel was checked to maximum temperatures of 600, 900, and 1350°C, respectively. A tentative reaction-rate curve was derived for the UN–Zircaloy-2 system. Stoichiometric UN is resistant to corrosion by water at 300°C; hyperstoichiometric and hypstoichiometric UN are not. Weight gain-versus-time curves for UN exposed to dry oxygen and carbon dioxide were obtained. (N.W.R.)

543 (CEA-2291) MICROANALYSEUR A SONDE ELECTRONIQUE. DISPOSITIF DE BALAYAGE LINEAIRE. (An Electronic Probe Microanalyzer. A Linear Scan Device). A Kirianenko and F. Maurice (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). 1963. 19p.

The Castaing electronic probe micro-analyser makes possible static analysis at successive points. For two years this apparatus has been equipped by its constructor with an automatic device for surface scanning. In order to increase the micro-analyser's efficiency a "linear" scan device has been incorporated making it possible to obtain semi-quantitative analyses very rapidly. (auth)

544 (CEA-2310) CONTRIBUTION A L'ÉTUDE DU PROCÉDÉ DE LA ZONE FONDUE VERTICALE. (Contribution to the Study of the Vertical Molten Zone Process). Michel Lenzi (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucleaires, Saclay). 1963. 63p. Thesis submitted to Universite, Paris.

A description is given of construction and use of several molten zone apparatuses operating either vertically or horizontally. Efficient purification of uranyl nitrate hexahydrate was carried out but less successful results were obtained in the case of other hydrated double salts and of zirconyl chloride in the hydrochloric gel form. A demonstration and study were made of the dissymmetry in the direction of the transport of the impurity during the purification by a vertical molten zone process. (auth)

545 (GEAP-4368) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Progress Report No. 6. H. H. Klepfer, J. L. Jaech, D. L. Douglass, R. E. Blood, and H. E. Perrine (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 42p. (EURAEC-834)

Zr–Cr and Zr–Cu–Fe alloys show the most promise for service in steam at 300-500°C. Maximum resistance to corrosion hydrogen embrittlement requires high initial ductility and low, perhaps less than ~2.5 at. %, total alloy content. For any composition, susceptibility to hydrogen embrittlement depends on crystallographic texture of the component; under certain circumstances hydrogen embrittlement may be highly anisotropic. Three alternate fabrication schedules were evaluated; and results indicate that the Zr–Cu alloy tested is less sensitive to heat treatment than is the Zr–Cr alloy tested. Raising the final alpha annealing temperature from 565 to 788°C gives better over-all corrosion and hydriding performance for both the Zr–Cr and Zr–Cu alloy tested. Beryllium additions to Zr–Cr or Zr–Cu do not appear to be advantageous. Nickel additions to Zr–Cu do not give an overall improvement. Nickel additions to Zr–Cu give about the same improvement over Zr–Cu as did iron additions to Zr–Cu in the first-round tests. (auth)

546 (IP-488) THE ELECTROLYSIS OF SOME LIQUID ALLOYS. John C. Angus (Michigan. Univ., Ann Arbor. Coll. of Engineering). Jan. 1961. Contract AT(11-1)-771. 130p.

A study was made: (1) to devise a technique whereby electrical mobilities in molten alloys at high temperatures can be determined, (2) to obtain accurate data on several Bi alloys, (3) to investigate a correlation that states that the component with the smallest atomic weight migrates to the cathode, and (4) investigate the possibility of the existence of intermetallic compounds in liquid Na–Hg alloys by means of electrodiffusion experiments. A method was devised for measuring electrical mobilities. The technique was tested by reproducing the value of the mobility reported for Na in dilute Na amalgams. The earlier value is $+1.19 \times 10^{-4}$ cm^2/sec-volt; the value obtained in this study is $+1.23 \pm 0.23 \times 10^{-4}$ cm^2/sec-volt at the 95 per cent confidence level. The technique was applied to the molten alloys Bi–Cu, Bi–Mg, Bi–Zr, and Bi–U. The following mobilities in $10^4 \times$ cm^2/sec-volt were determined: Cu, at 0.5 wt % and 500°C, -1.85 ± 0.25; Mg, at 0.5 wt % and 350°C, -578 ± 0.98; Zr, at 0.0567 wt % and 510°C, $+2.61 \pm 2.54$; U, at 0.0144–0.310 wt % and 445–500°C, $+2.57 \pm 0.67$. The mobilities are reported at the 95 per cent confidence level. A positive mobility indicates the solute moves to the anode, a negative mobility means motion to the cathode. The

sources of error were examined and suggestions given for increasing the accuracy of the technique. Experiments on 0.5 wt % Na amalgams show that the direction of transport of Na is to the anode when the temperature is below a certain value, and to the cathode when the temperature is above this value. The exact temperature of the reversal is uncertain since the experimental technique is not sufficiently sensitive to determine very low mobilities. It occurs in the range from 270 to 310°C. The reversal is interpreted as caused by the thermal decomposition of intermetallic compounds existing in the melt. This effect, which was predicted on the basis of the atomic mass correlation, has heretofore never been observed. It supplies additional evidence to that already available from thermodynamic, x-ray, and viscosity measurements for the existence of compounds in liquid alloys. In addition, a mechanism is presented as a possible explanation for the empirically observed correlation. (auth)

547 (LAMS-2898) COMPACTION AND SINTERING OF PuO_2–TYPE 302B STAINLESS STEEL POWDER MIXTURES. W. C. Pritchard, K. A. Johnson, and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). Jan. 3, 1963. Contract W-7405-eng-36. 43p.

The effects of compaction pressures, sintering temperatures, and PuO_2 preparation methods on pellets of type 302-B stainless steel and PuO_2 powders and mixtures of these were investigated. The pellets were compacted at pressures of 20 to 100 tsi followed by sintering in argon at 1175 to 1680°C. Densities, composition, and the effect of a binder are correlated with the results of metallographic examination. Definite evidence of a reaction between PuO_2 and type 302-B stainless steel was obtained. The effect of the addition of 3 wt % of type 302-B stainless steel to Mo–PuO_2 pellets was also investigated. (auth)

548 (NAA-SR-8507) PREPARATION OF URANIUM METAL BY CARBON REDUCTION. W. G. Smiley (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). [1962]. Contract AT(11-1)-Gen-8. 15p.

Pure uranium metal was prepared by heating oxide–carbon mixtures in a UO_2 crucible in vacuum. Uranium oxycarbide was formed initially; temperatures from 1790 to 1920°C were used to decompose it. Carbon content of the produce ranged from 0.05 down to 0.01 wt %. Evaporation losses were observed, but could be reduced to a reasonable level in large-scale production. The method may be useful in UC fuel reprocessing as well as in uranium production. (auth)

549 (NP-13241) RESEARCH ON TANTALUM AND MOLYBDENUM BRAZING TECHNIQUES. Quarterly Progress Report NOR-63-178. A. H. Freedman and E. B. Mikus (Northrop Norair, Div. of Northrop Corp., Hawthorne, Calif.). Oct. 1963. Contract AF33(657)-11227. 41p.

A literature survey was conducted which indicated that: no completely satisfactory conventional or high remelt temperature braze systems were developed for molybdenum and tantalum, the diffusion sink and reactive brazing concepts offer the most potential for increasing joint remelt temperatures, titanium-base alloys offer the most promise for molybdenum and tantalum diffusion sink braze alloys, and niobium-base alloys offer the most promise for conventional brazing of tantalum. A number of diffusion sink braze alloys were developed and will be evaluated on the joints. The molybdenum braze alloys are: Zr–25Ti–32V, Ti–8Ni–7Si, Ti–25Cr–10Ni, and Zr–34Ti–33V. The tantalum braze alloys are: Zr–25Ti–32V, Ti–27V–7Fe, Ti–29V–2Si, Ti–28Zr–16Mo–10Ta, and Ti–21.5V–1.5Si–25Ta. These braze alloys will utilize diffusion sink additions of molybdenum and/or tantalum. Reactive brazing will incorporate additions of carbon and/or boron. The Nb–25V and Nb–30Ti alloys were selected for conventional brazing of tantalum. Pre-braze cleaning procedures for tantalum and molybdenum were selected and their applicability verified experimentally. Methods were developed for placing diffusion sink powders at fillet and node areas on honeycomb specimens. (auth)

550 (NP-13276) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Mary F. Banks, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 1963. Contract AF33(616)-7747. 15p.

A current listing of 82 selected documents and journal articles in abstracted form is presented on subjects within the technical scope of DMIC. The references are arranged in sections dealing with high-strength alloys, light metals, nonmetallics, refractory metals, and miscellaneous. Author and subject indexes are included. (D.L.C.)

551 (EURAEC-224) RESEARCH INTO ZIRCONIUM HYDRIDE IN ZIRCALOY-2 AND Zr–Nb ALLOYS. Quarterly Report No. 1, October 1, 1961–December 31, 1961. (Siemens-Schuckertwerke A. G., Erlangen, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 024-61-10-RDA. 6p. (A translation).

The partial deliveries of sample materials were analyzed. A heatable vacuum apparatus was constructed for the charging of samples with specific volumes of hydrogen. A gas chromatograph is currently being calibrated with various gases. (N.W.R.)

552 (EURAEC-265) PRODUCTION OF UO_2 AND UO_2–BeO MIXED PELLETS. Quarterly Report No. 4, October 1–December 15, 1961. (Battelle Institut e. V., Frankfurt am Main). Feb. 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 015-60-9-RDA. 8p. (A translation).

Test bodies were fabricated from UO_2 and BeO–UO_2 mixtures for implementing dilatometric and heat conductivity measurements. The heat conductivity monitoring installation was finalized and measurements of UO_2 sintered bodies were made in order to test the accuracy of the measuring equipment and to perfect the installation. A dilatometer was modified with the scope of using pellets as test samples instead of the usual prisms. (auth)

553 (EURAEC-647) DEVELOPMENT OF PROCESSES FOR THE PREPARATION OF URANIUM CARBIDES AND CERMETS ON A UC BASE. Quarterly Report No. 11, January 1 to March 31, 1963. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 088-62-7 RDD. 12p. (A translation).

The UC reaction furnace for semi-continuous operation was tested. After a stepless transmission, by means of which it was possible to cast more slowly, was fitted, and after an arc centering coil was applied to the centrifugal casting furnace, a series of new tests were made for casting rods whose diameter exceeded 20 mm. These experiments, formerly made with a normal crucible and had produced rods with flaws or with a too high carbon content, were successful. In a series of melting and casting experiments with a tilting furnace, it was found out that a crucible which, seen from the side, has a rectangular cross-

section, yielded the best results. A crucible with a separately cooled pouring edge is being prepared. (auth)

554 (TRG-Inf-Ser-330) ON BOILER OPERATION. RECENT OBSERVATIONS AND KNOWLEDGE CONCERNING THE BEHAVIOUR OF FERRITIC AND AUSTENITIC BOILER STEELS. I. Class. Translated by G. G. Kinnane (U.K.A.E.A. Reactor Group, Risley Lancs, Eng.), from Mitt. Ver. Grosskesselbesitzer, No. 80, 326-37(Oct. 1960). 22p.

The creep behavior of steel in boilers is reviewed relative to planning, operation, and testing during service. Crack formation and sensitivity to progressive rupture are considered. The use of non-austenitic special steels is discussed briefly. A detailed treatment is presented of the uses, properties, and problems of austenitic steels, particularly Nb-stabilized steels. Welds between ferritic and austenitic steel are also reviewed. The problem of external corrosion of austenitic superheater tubes by flue gases is discussed. It is concluded that the use of fully austenitic steel is justified. (D.L.C.)

555 RUBBER APPLICATIONS. A SURVEY. D. F. Aitken. Nucl. Eng., 8: 409-11(Nov. 1963).

The physical properties of several synthetic rubbers are summarized; their improvement by compounding is also discussed. Additionally, the radiation resistance of rubbers and the improvement thereof are considered. Problems of testing rubbers are discussed, as is the production of gauntlet gloves. (D.C.W.)

556 FABRICATION AND PROPERTIES OF SOLID SOLUTIONS OF ZIRCONIUM DIOXIDE WITH RARE EARTH OXIDES. E. K. Keler and A. B. Andreeva (Chemical Inst. of Silicates, Academy of Sciences, USSR). Ogneupory, No. 5, 224-31(1963). (In Russian)

Reactions of ZrO_2 with Ce, Y, and La oxides at 1400°C formed cubic solid solutions. The specimens were sintered at 1700 to 1750°C for 3 hrs. A complete stabilization of ZrO_2 was reached at 1700 to 1750°C with 20 mole % CeO_2, 15 mole % Y_2O_3, or 25 mole % La_2O_3. New refractory materials were prepared from solid solutions of ZrO_2–20% CeO_2, ZrO_2–80% CeO_3, ZrO_2–15% Y_2O_3, ZrO_2–80% Y_2O_3, and ZrO_2–25% La_2O_3 at 1750°C. (R.V.J.)

557 FUEL ELEMENTS. L. M. Wyatt. p.125-70 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The five types of fuel that can be used in a gas-cooled reactor are discussed with respect to mechanical and physical properties and fabrication. The physical and mechanical properties and methods of fabrication for various canning materials are also presented. (C.E.S.)

558 STEELS. R. W. Nichols and B. Watkins. p.220-66 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The selection of composition and thickness of steels to be used in providing thermal and neutron shielding, in supporting the graphite structure, in providing heat-exchanger tubing and piping, and in providing the pressure containment for the main gas-cooling circuit in gas-cooled graphite-moderated reactors is discussed. Brittle fracture, the effects of neutron irradiation, high temperature properties, carbon dioxide corrosion, weldability, fabrication control, inspection, and monitoring for irradiation damage are considered. (C.E.S.)

559 PROCEEDINGS OF THE FIFTH CONFERENCE ON CARBON. VOLUME 1. Held at the Pennsylvania State University, University Park, Pennsylvania. New York, Pergamon Press, 1962. 648p.

Seventy articles are included: separate abstracts were prepared for 31. Seven articles previously abstracted in NSA include information on: intercalation of cobalt(II) chloride in graphite; degassing behavior of commercial graphites; effect of air flow rate on C – O_2 and CO – O_2 reactions; thermal changes with time and distance in air-cooled graphite channels; chemical reactivity of BNL graphite and its effect on the length channel cooled by air; combined effects of temperature, flow rate, diameter, and chemical reactivity on the length of channel cooled by air; and effect of temperature radioinduced contraction of reactor graphite. The remaining 32 articles include information on: electronic properties; surface properties; adsorption, and reactivity; carbonization, graphitization, and structure; and mechanical and thermal properties, friction and wear, carbon technology. Separate author and subject indexes are included. (P.C.H.)

For abstracts of individual papers see: 249, 250, 251, 252, 253, 408, 411, 412, 413, 586, 587, 588, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 666, 667, 668, 669, 670, 671, 672, and 1275.

Corrosion

560 (AERE-R-4348) SOME FACTORS WHICH AFFECT THE RATE OF OXIDATION AND HYDROGEN ABSORPTION OF ZIRCALOY-2 IN STEAM. B. Cox (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). July 1963. 56p.

Data, which were accumulated over several years, on the effect of a number of variables on the oxidation and hydriding of Zircaloy-2 are presented. The use of this information to eliminate some of the inaccuracies in present estimates of the behavior of Zircaloy-2 over long periods of time is demonstrated. (auth)

561 (ARF-B229-17) HIGH-TEMPERATURE BERYLLIUM CORROSION PROTECTION. Phase Report, Coating Development and Evaluation Phase, September 22, 1961 to May 15, 1962. (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Mar. 20, 1963. For Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Contract AT(11-1)-578. 31p.

Several coating techniques were studied with the objective of protecting beryllium neutron reflectors from oxidation during long-time ground testing of a SNAP-8 experimental reactor. The techniques include enameling, metallic slurry coating, and pack-cementation conversion coating. In addition, several commercial coatings for beryllium were evaluated. Based on screening and comparative oxidation evaluation studies an anodic coating was selected as being capable of affording the necessary protection. (auth)

562 (DPST-63-70-8) PROGRESS REPORT ON MICROPROBE STUDY OF ZIRCALOY CORROSION FILMS. (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). Sept. 1963. Contract AT(07-2)-1. 2p.

A sample of corroded Zircaloy-2 was examined for concentration of alloying elements in the matrix of the metal between intermetallic compounds. Results show that the concentrations of iron, chromium, and nickel in regions removed from the intermetallic compounds are significantly less than the overall composition. The intermetallic compounds are also analyzed and discussed. (N.W.R.)

563 (KAPL-2285) CORROSION RESISTANCE OF ANNEALED PREOXIDIZED ZIRCALOY-2. A. E. Bibb and

E. J. Callahan (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 4, 1963. Contract W-31-109-eng-52. 30p.

An evaluation was made of the effect of various stress-relief annealing parameters on the subsequent corrosion resistance and hydrogen up-take tendencies of preoxidized Zircaloy-2. The effect of annealing times of one, two, and five hours at temperatures of 752, 842, 1022, and 1112°F were evaluated. The data showed no significant effect of annealing one, two, or five hours at 752 or 842°F on the subsequent corrosion of preoxidized Zircaloy-2 in 680°F water. Also, annealing one, two, or five hours at 752 or 842°F or one or two hours at 1022°F has no effect on the corrosion of the material in 750°F steam. All annealing conditions that were more rigorous had significant deleterious effects. The deleterious effects of the latter conditions were attributed to changes in the anion vacancy magnitude and gradient induced in the oxide by the vacuum annealing. Hydrogen uptake data indicated that the kinetics of hydrogen pickup in 680°F water are not directly related to the kinetics of the corrosion reaction, but only to the magnitude of corrosion. (P.C.H.)

564 (MSAR-63-142) EFFECT OF 1200°F SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 37, September 1963. (MSA Research Corp., Callery, Penna.). Oct. 16, 1963. Contract AT(11-1)-765. 39p.

A research program is being conducted on the effects of sodium and contaminants at 1200 and 1100°F on the mechanical properties of Type 316 stainless steel and $2\frac{1}{4}$ Cr–1 Mo carbon steel, as compared to air and helium. Tests 1 and 2 were completed, and the final creep rates for 316 stainless steel and carbon steel in sodium containing 30 ppm O_2 are plotted. The shakedown operation phase of Test 3 (stainless steel in high-carbon sodium) is in progress. The results of some fatigue and creep-rupture runs in Test 4 ($2\frac{1}{4}$ Cr–1 Mo carbon steel in high-oxygen sodium) indicate about the same fatigue life as in low-oxygen sodium and helium, and a slightly shorter creep-rupture life. (D.L.C.)

565 (NP-13243) OXIDATION RESISTANT HIGH TEMPERATURE PROTECTIVE COATINGS FOR TUNGSTEN. First Quarterly Progress Report, May 15–Aug. 15, 1963. (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Contract AF33(657)-11151. 52p.

Oxidation tests conducted on Ti–Zr–(Si–W)–O and (Si–W)–O coated 60 mil tungsten sheet at 3400–3500°F demonstrated the stability of both coating systems at reduced pressures (air) of 25, 100, and 1000 microns for periods of time up to 1 hr at 3400–3500°F. In addition, atmospheric tests at 300°F conducted on coated specimens after reduced pressure exposure at 3400–3500°F showed the ability of the coating systems to retain one atmosphere oxidation resistance. Coating characteristics of arc cast 60 mil tungsten sheet were found to be essentially the same as that for powder product sheet with respect to application of the Ti–Zr–(Si–W) and the (Si–W) coating systems. Process parameters for coating in a larger retort were identified utilizing both arc cast and powder product tungsten material. Modification of a large vacuum chamber for dynamic low pressure testing was initiated. Successful tests, in which a plasma gun was fired during continuous evacuation of this chamber, were made. Calorimetry tests were also conducted to determine heat flux conditions at reduced pressure. (auth)

566 (NP-13284) THE OXIDATION OF COLUMBIUM AT 850°C IN OXYGEN AT LOW PRESSURES (thesis). Joe Earl Spruiell (Tennessee. Univ., Knoxville). June 1960. 150p.

A study was made of the oxidation of Nb in purified O_2 at 850°C and pressures of 5×10^{-5}, 1×10^{-4}, and 5×10^{-4} mm Hg for time periods up to 12 hours. Oxidation at an air pressure of 6×10^{-6} mm Hg was also investigated. Rate determinations were made by a gravimetric method involving the accurate measurement of the deflection of a sensitive quartz helix. The weight-gain versus time curves consisted of an initial, linear portion, the length of which depended inversely on the oxygen pressure, followed by a region in which the oxidation rates decreased with time. Electron micrographs of the oxidized surfaces and optical micrographs of both oxidized surfaces and metallographically prepared cross sections of the specimens indicated that oxidation proceeded initially by a process of nucleation and growth of small, geometrically shaped, well oriented crystals which were tentatively identified as an oxide phase. Single-crystal studies showed that the shapes and orientation of these initial growths depended upon the crystallographic face upon which they formed. The density of these geometrical growths was of the order of 10^7 to 10^8 per cm^2. Rapid solution of oxygen into the Nb accompanied the formation of the original crystal growths on the surface. It was found through microhardness measurements that oxygen, due primarily to grain-boundary diffusion, could reach the center of small-grained, polycrystalline specimens rapidly enough so that essentially no macroscopic concentration gradient existed across the specimen. The result of this rapid diffusion and of local supersaturation was a process of internal oxidation due to precipitation of NbO at nucleation sites at or near grain boundaries. It was determined that the process of internal oxidation occurred at the temperature of oxidation and only partially during cooling to room temperature. It is believed that this study has produced the first reported observation of a process of internal oxidation in a pure metal. The deviations from linearity in the rate curves were correlated with the formation of significant thicknesses of NbO_2, formed by oxidation of internally nucleated NbO crystals which had grown so as to protrude through the surface of the specimen. The linear rates observed in the initial stages of oxidation indicated that the oxidation rate was controlled by either an interface process or a steady-state situation involving diffusion through a thin film which maintained a constant thickness. (auth)

567 THE EFFECT OF DISSOLVED OXYGEN ON THE OXIDATION OF ZIRCALOY-2 BY STEAM. B. Cox and B. R. Harder (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Electrochem. Soc., 110: 1110-13(Nov. 1963).

Predetermined amounts of oxygen were added to Zircaloy-2 by three methods that were expected to give widely different distributions of the oxygen in the metal. Subsequent oxidation of the specimens in steam showed that increases in the oxidation rate could be ascribed largely to the inhomogeneous distribution of the oxygen. The closer a homogeneous oxygen distribution was approached, the closer the oxidation rate approached that of low-oxygen material. If the oxygen distribution in the surface was uniform, the presence of an oxygen gradient through the specimens did not result in an increase in the oxidation rate. (auth)

568 MECHANISM OF THE OXIDATION OF A URANIUM-ONE WEIGHT PER CENT COPPER ALLOY. J. E. Antill and K. A. Peakall (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Electrochem. Soc., 110: 1146-8(Nov. 1963).

The effects of copper addition (1%) on the oxidation resistance of uranium in CO_2 was studied at 500 to 1000°C. Electron microscopy revealed that at the high temperatures at which the beneficial effect of copper was apparent a layer of the intermetallic compound UCu_5, or of copper containing uranium oxide formed at the metal/oxide interface. Specimens at 680 and 800°C had a bright copper-colored layer at the oxide/metal interface and a second dark oxide phase embedded in the light gray uranium dioxide. In order to confirm the protective role of the copper-colored layer, specimens of the intermetallic compound were prepared by arc melting and oxidized in the thermal balance reaction chamber. It was found that the attack of the compound was approximately one tenth of that of the alloy. It was concluded that at least part of all of the protection is due to the formation of a layer of UCu_5 or copper containing uranium oxide at the metal/oxide interface. (P.C.H.)

569 PHOTOGALVANIC EFFECTS WITH ANODIZED ZIRCONIUM AND NIOBIUM ELECTRODES. Robert E. Salomon, George B. Adams, and Wendell M. Graven (Temple Univ., Philadelphia). J. Electrochem. Soc., 110: 1163-5(Nov. 1963).

Attempts were made to elucidate the nature of photoeffects by studying anodized Zr and Nb electrodes. A freshly polished Zr electrode when immersed in solution showed an initial potential, relative to the reference electrode, of about −1.2 v. As oxide began to form on the electrode surface the potential became less negative. Zr electrodes that were anodized with formation voltages greater than 10 v exhibited potentials, relative to the reference electrode, of −0.03 to −0.06 v in the absence of illumination. Application of the Zr electrode of a positive polarization voltage, well below the film-formation voltage, produced a small current in the absence of illumination. A considerable larger steady current resulted from illumination of the electrode. Niobium electrodes that were anodized with formation voltages greater than 10 v exhibited behavior under illumination similar to that of Zr. However, differences between rest potentials and steady-state photopotentials were considerably lower and photocurrents were considerably greater with Nb. Both short-circuit photocurrents and photocurrents with positively polarized Nb electrodes were observed. Photocurrents decreased with increasing film thickness. (P.C.H.)

570 NEW HEAT TREATMENT CUTS ZIRCALOY-2 CORROSION, HYDROGEN EMBRITTLEMENT. Nucleonics, 21: No. 11, 70(Nov. 1963).

It is shown that Zircaloy-2 corrosion in 750°F, 1,500-psi steam can be reduced up to 20% and embrittling hydrogen absorption can be cut 40% by heat treatment to disperse the intermetallic-compound stringers. The new concept is based on microstructure and its effects. (R.E.U.)

Fabrication

Refer also to abstract 346.

571 (AD-297246) REFRACTORY ALLOY FOIL ROLLING DEVELOPMENT PROGRAM. Interim Report No. 2, October 15, 1962–January 15, 1963. (Du Pont de Nemours (E. I.) & Co. Metals Center, Baltimore). Contract AF33(657)-8912. 30p.

The melting of three niobium-base alloy and two tantalum-base alloy ingots by arc-casting is described. The alloys were Nb–10% W–1% Zr–0.1% C (D-43), Nb–5% Mo–5% V–1% Zr (B-66), Nb–10% W–2½% Zr (Nb–752), Ta–10% W, and Ta–8% W–2% Hf (T-111). The process consisted of hydrostatic compaction of elemental powders into electrodes followed by double consumable arc melting to yield 6-inch diameter ingots. Analytical and metallurgical testing of the ingots is described. (auth)

572 (AD-421974) WELDING OF REFRACTORY METALS. Interim Report No. 1, October 1, 1962 to December 30, 1962. (Universal-Cyclops Steel Corp., Bridgeville, Penna.). Jan. 1963. Contract NOw 63-0043-c. 17p.

Some equipment and facilities to be used in establishing optimum production techniques and materials for welding refractory metals into shapes and units suitable for aircraft and missile components are described. An industrial survey was prepared. (D.C.W.)

573 (AD-422116) WELDING OF REFRACTORY METALS. Interim Report No. 3, April 1, 1963 to June 30, 1963. F. D. Seaman and D. J. Seman (Universal-Cyclops Steel Corp., Bridgeville, Penna). July 1963. Contract NOw 63-0043-c. 48p.

The weld parameters (speed, amperage, electrode configuration, atmosphere, and arc length) are discussed with respect to the physical dimensions of the weld. Descriptions of the welding equipment to be used are included. (auth)

574 (BRB-76) A MACHINING CLEAN-UP STUDY OF EXTRUDED URANIUM (MARK V-B) TUBES. A. Rocco, Q. C. Carloni, and L. Lewis (Bridgeport Brass Co., Seymour, Conn.). Nov. 8, 1963. Contract AT(30-1)-1405. 34p.

Good surface quality and low slug rejection rates showed that the OD machining stock could be reduced on extruded uranium tubes (Mark V-B). Normally 0.125 in. is added to the desired tube OD dimensions for surface clean-up purposes. Data obtained revealed that a lesser amount, approximately 0.050 in., is needed for clean-up purposes. The reduction in OD machining stock could result in approximately a 9% increase in metal yield per extruded billet. The yield increase could represent a significant saving during production runs and subsequent processing of the extruded tubes (machining, metal recycle). Therefore, OD machining stock of 0.125, the current practice, appears to be costly and wasteful. Step-down machining data revealed that the largest decrease in OD machining stock can be made by employing lubricant-coated billets, either as-cast or machined, and an integral die design. The lubricated, machined billets presented the lowest clean-up values. All average clean-up values obtained were significantly lower than the amount of OD stock (0.125 in.) presently designed on extruded uranium tubes (Mark V-B). Other pertinent results revealed that significantly lower extrusion upset (break-through) and run pressures were obtained employing lubricated billets and an integral die design in comparison to employing conventional extrusion parameters. (P.C.H.)

575 (CEA-2290) BARRE COMBUSTIBLE A THERMOCOUPLE, GAINEE DE ZIRCALOY. (Zircaloy-Sheathed Fuel Element Rods Fitted with Thermocouples). Bruneau Bernardy de Sigoyer, Francois Jacques, and Paul Thome (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 39p.

In order to carry out thermal conductivity measurements on UO_2 in conditions similar to those under which fuel rods are used, it was necessary to measure the temperature at the interior of a fuel element sheathed in Zircaloy. The temperatures are taken with Thermocoax type thermocouples, that is to say fitted with a very thin sheath of stainless steel or Inconel. It is known also that fusion welding of Zircaloy onto stainless steel is impossible and

that high temperature welded joints are very difficult because of their agressiveness. The technique used consists in brazing the thermocouples to relatively large stainless steel parts and then joining these plugs by electron bombardment welding to diffused stainless steel-Zircaloy couplings. The properties of these diffused couplings and of the brazed joints were studied; the various stages in the fabrication of the containers are also described. (auth)

576 (CNLM-4351) HIGH VOLTAGE ELECTRON BEAM WELDING OF W–Re THERMOCOUPLES. J. Doyle (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Dec. 13, 1962. Contract AT(30-1)-2789. 8p.

An evaluation was made of the joints of electron beam welded W-5 Re/W-26 Re thermocouples by electrical continuity through the W–Re wires, discontinuity from wires to cladding, and x-ray and metallographic examination. The weldments were found to exhibit incomplete fusion in cap welds and some porosity in undesirable lead junction shapes. Changes necessary to improve the joint design are given. (P.C.H.)

577 (EURAEC-736) STUDY OF THE SHAPING OF UO_2 POWDERS BY MECHANICAL COMPRESSION AND THEIR SINTERING ON A PILOT SCALE IN AN ATMOSPHERE OF CRACKED AMMONIA. A. Porneuf (Compagnie Industrielle des Combustibles Atomiques Frittes, Corbeville, par Orsay (Seine-et-Oise). France). 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 59p. (EUR-343.f)

The studies and research work have led to the development on a pilot scale of an original method of shaping uranium dioxide. After all granulation tests had been carried out, the wet granulation methods were rejected and dry granulation methods, without binder, adopted instead. The resultant method of shaping with a double compression cycle was found to have a general application; it gives improved densification and leads to a considerable reduction of dispersion during shaping and sintering. The "single cycle" method, which is an attempt to simplify the previous method, can only be applied to certain UO_2 powders having a particularly favorable morphology and friability. The dry granulation studies have enabled one to give a tentative interpretation of the differences in sinterability existing between UO_2 powders of the same specific surface area. The study of the sintering dispersion occurring in batch furnaces and the continuous furnace built at the C.I.C.A.F. shows that a feature of the latter furnace is that the sintered products obtained are highly regular, both in the entire sintering process and in the course of the different bakings of the same UO_2 powder. Hence continuous furnace sintering leads to a considerable reduction in the dispersion of densification and for this reason is appreciably different from the sinterings produced in a batch furnace. (auth)

578 (NAA-SR-8578) JOINING OF APM ALUMINUM ALLOYS FOR REACTOR FUEL APPLICATIONS. E. C. Supan, W. H. Friske, and G. V. Alm (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [June 1, 1963]. Contract AT(11-1)-Gen-8. 23p.

Because of the dispersed oxide phase in APM alloys, these materials have been difficult to join by common fusion welding and brazing techniques. A discussion is presented of eutectic bonding, flash welding, and cold pressure bonding, the specialized joining techniques that have been found suitable for joining this unconventional and difficult-to-weld material. Silver eutectic bonding is the principal method now being used for making helium leak-tight end closures in finned APM tubing. Flash welding is the best alternate method thus far investigated. (auth)

579 (NP-13267) WELDING OF REFRACTORY METALS. Interim Report No. 2, January 1–March 31, 1963. (Universal-Cyclops Steel Corp., Bridgeville, Penna.). Apr. 1963. Contract NOw-63-0043-c. 26p.

An industrial survey on the welding of refractory materials, especially tungsten, molybdenum, niobium, and tantalum, is summarized along with the welding techniques used by the industrial firms. A study of welding equipment and materials is under way. Photographic techniques for viewing the anode spot during welding are discussed. (N.W.R.)

580 (UCRL-7388) A CRUCIBLELESS VACUUM INDUCTION MELTING AND CASTING PROCESS FOR CONSOLIDATION AND PURIFICATION OF REACTIVE METALS. R. F. Bunshah and R. S. Juntz (California. Univ., Livermore. Lawrence Radiation Lab.). [1963]. Contract W-7405-eng-48. 17p. (CONF-04-3)

From American Vacuum Society Vacuum Metallurgy Conference, 6th Annual Conference on Vacuum Metallurgy, New York, June 1963.

A crucibleless vacuum induction melting and casting technique for consolidation of reactive metals without contamination is described. The raw material compact is placed on a water-cooled copper stool and surrounded by an induction coil. The melt is supported on the bottom by the stool and at its sides by the pinch effect of the opposing currents and is stabilized into a conical shape. Various in-place and bottom-casting techniques are used to cast the melt. (auth)

581 (EURAEC-70) PREPARATION OF URANIUM AND MIXED CARBIDES AND UC-BASED CERMETS, CORROSION REFINING AND PROPERTY TESTS. Quarterly Progress Report No. 3, January–March 1961. P. Himmelstein, F. Hofmann, B. Liebmann, and L. Schafer (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. 11p. (A translation).

The solid state reaction designed to produce uranium carbide from mixed uranium dioxide and graphite powders was studied. Particular attention was paid to the production of stoichiometric UC with a carbon content of 4.8 ± 0.1 wt %. It was possible to remain within these limits by determining the over-stoichiometric oxygen content of the uranium oxide and by weighing the powder in line with the following equation: $UO_{2+X} + (3 + X) \rightarrow UC + (2 + X)\,CO$. A start was made with the construction of a 4000 ampere skull-melting furnace for melting and for centrifugal casting of UC. (auth)

582 (EURAEC-282) STUDY ON THE SINTERING OF UO_2–PuO_2 MIXTURES. Special Report No. 4. I. Lafontaine and E. Vanden Bemden (Brussels. Centre d'Étude de l'Énergie Nucléaire and Société Belge pour l'Industrie Nucléaire, Brussels). [nd]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 027-60-7RDB. 48p. (A translation). (BN-6203-13)

A study was carried out on the sintering of UO_2–PuO_2 mixtures of PuO_2 concentrations of 5, 10, and 20%. The sintering kinetic curves were determined using a photographic device, and were compared to those found for pure UO_2 under the same conditions. The different factors which influence the sintering are analyzed and optimum values established. The interdiffusion of plutonium and uranium oxides during sintering is considered. (D.L.C.)

583 (EURAEC-324) DEVELOPMENT OF A FABRICATION PROCESS FOR URANIUM CARBIDES AND CERMETS WITH UC BASES. Quarterly Report No. 7, January 1–March 31, 1962. P. Himmelstein, F. Hofmann, B. Liebmann, and L. Schaefer (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 061-61-5-RDD. 18p. (A translation).

Pellets consisting of a (UO_2 + 3C) mixture were reduced to UC by reaction in a semi-continuous installation. In the fabrication, a small filling funnel was used on the pellet press. When a large funnel was utilized, a separation of the UO_2–C mixture occurred. The construction of the water-cooled copper crucible for the skull melting furnace was completed. The tests concerning the influence of furnace atmospheres, melting current, and melting time were concluded. As the results show, the oxygen content of the cast rods is considerably lower than that of the prereacted pellets utilized for melting. During the melting, the carbon content of the UC increases owing to absorption of carbon from the graphite electrode. The increase in carbon content is influenced to a greater extent by the melting time than by the current. In order to increase the accuracy of the carbon analyses, the construction of a macro-apparatus was commenced. (auth)

584 THE EFFECT OF STRAIN RATE ON THE ROOM TEMPERATURE YIELD STRESS OF "FLASH-ANNEALED" NIOBIUM. A. Fourdeux and A. Wronski (Union Carbide European Research Associates, s.a., Brussels). Acta Met., 11: 1270-3(Nov. 1963).

A flash-annealing technique whereby the yield stress at a strain rate of 1% min^{-1} can be lowered to ~3.5 kg mm^{-2} was used to investigate the effect of strain rate on flash-annealed Nb. It was found that the results can be fitted on to three linear ranges, each of the form of the equation $\sigma_Y = A + A' \log_{10}\dot{\epsilon}$. For $\dot{\epsilon} < 2\%$ min^{-1} no yield points were observed and the yield stress was taken to be that at the apparent proportional limit. For $2 \leq \dot{\epsilon} \leq 100\%$ min^{-1} some specimens exhibited yield points and some not. For $\dot{\epsilon} > 100\%$ min^{-1} there was always a yield drop and the U.T.S. was lower than the upper yield stress. If all the results for two of the ranges are taken together, there is some evidence for a previously proposed third range. It appears that for Nb impurities can control the deformation mechanism. (P.C.H.)

585 APPLICATION OF ZIRCONIUM AND ITS COMPOUNDS IN THE MAKING OF HARD AND REFRACTORY ALLOYS. M. S. Koval'chenko (Inst. of Powder Metallurgy and Special Alloys, Academy of Sciences, USSR). Primenenie Tsirkoniya i ego Soedin. v prom. Akad. Nauk Ukr. SSR, Inst. Obschch. i Neorgan. Khim., Materialy Soveshch., Kiev (1960), 14-23(1962).

A review is presented on the characteristics and applications of Zr compounds with C, B, N, and Si for hard, high melting point products with elevated high-temperature strength, high E, chemical inertness to both acids and alkalies, refractoriness in contact with molten metals, and high electric and thermal conductivity. The preparation of technical ZrC by carbon-black carbidization (ZrO_2 + 3C = ZrC + 2CO), that of pure ZrB_2 by borocarbide reduction of ZrO_2 ($2ZrO_2 + B_4C + 3C = 2ZrB_2 + 4CO$), that of pure ZrN by nitriding of metallic Zr powder at 1200°C, and that of $ZrSi_2$ by pressing Zr and Si powders in stoichiometric ratio and sintering at 1200°C in an Ar or H atmosphere are described in detail. Methods developed for hot pressing (simultaneous pressing and sintering) and by extrusion of mixtures of the powders with plastifiers (so-called friction-force pressing and sintering) are mentioned. A technology for the manufacture of ZrB_2 immersion thermocouples for use in steel, pig-iron, brass, and bronze melts is described, along with the high-temperature performance and thermal inertia of such thermocouples in steel-furnace tests. (TCO)

586 RECENT DEVELOPMENTS IN GRAPHITE IMPREGNATION. L. W. Graham, D. R. Perels, and W. J. Greenwood (Hawker Siddeley Nuclear Power Co., Ltd., Langley, Eng.). p.567-74 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Impregnation processes were developed whereby chars derived from polyacrylonitrile and a condensation product of aniline and furfural are deposited in the pore systems of commercially available carbon and graphite. From the results of experiments carried out on specimens of a useful engineering size it is shown that with the proper choice of impregnating media and pyrolysis conditions, the density and strength can be increased significantly or alternatively the gas permeability markedly reduced. Fine grained graphites containing carbonaceous chars were produced with gas permeabilities lower than 10^{-6} cm^2/sec uniformly through substantial thicknesses with tensile strengths approaching 8000 psi. In pile grade material density increases in excess of 10% were achieved together with marked improvements in the mechanical properties. (auth)

587 PREPARATION OF HIGH-DENSITY GRAPHITE. P. Bergognon (Compagnie de Produits Chimiques et Electrométallurgiques Péchiney, France), P. Cornuault, J. Bentolila, and M. S. T. Price. p.600-10 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962. (In French)

A study was made of the manufacture of graphite, with as high a density as possible and, at the same time, a good texture. Suitable products, of density in excess of 1.90 g/cm^3, were prepared, using a graphite base and augmenting the particle size distribution with thermal carbon black. The effects of particle size distribution and of baking were included in the study. Some baking under a nitrogen pressure was carried out. As a result an increased density was achieved, so allowing the usual pitch impregnation to be avoided. The products thus obtained have, apart from their high density, a pore spectrum suitable for impregnation with thermosetting resins to give low permeability graphite after carbonization. (auth)

588 COMPACTION OF ARTIFICIAL GRAPHITE. J. R. May (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). p.611-24 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Sound high density cylinders of graphite were made by cold compacting finely ground artificial graphite at pressures of 60 tsi. Cylinders could be made only if the graphite used were freshly ground and finer than 25 μ. When stored in a moist atmosphere or heated to high temperatures, the graphite powder loses these compacting properties. It was observed that, while compressing to the same extent as the freshly ground material when under load in a die, the powders expanded much more on removal of the load. The heated powder showed no signs of cohesion, yet its particle size was substantially the same before and after heating. The compressive strengths of the compacts lay in the range 1700–4300 psi, depending on the moisture content of the graphite, and increased with increase in density. Cylinders also were made using a coarser graph-

ite that underwent a wet oxidation treatment using fuming nitric acid and potassium chlorate. The compacting properties of this graphite were affected in a similar way by moisture. The bonding of the graphite can be explained in terms of active sites being produced on grinding. In support of this, paramagnetic resonance measurements were carried out on both the as ground and the oxidized powders before and after compacting and also on the as ground powder after heating to 2400°C in argon. The as ground powder showed a resonance of approximately 10^{18} spins/g, which dropped considerably on heating and on compacting. The oxidized material had a stronger resonance than the as ground material, but it too dropped slightly on compacting. (auth)

589 NEW REMOTE FACILITY AND EQUIPMENT AT THE OAK RIDGE NATIONAL LABORATORY FOR FABRICATION OF FUEL RODS BEARING URANIUM-233 AND THORIUM OXIDE. J. D. Sease, A. L. Lotts, and F. C. Davis (Oak Ridge National Lab., Tenn.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 33-43(1963).

A fabrication facility and its related process equipment required to fabricate fuel rods containing U^{233}-thorium oxide by the bulk oxide-vibratory compaction route was constructed and operation is beginning at the Oak Ridge National Laboratory. The facility was specifically designed to fabricate ½-in.-dia × 46-in.-long Zircaloy-2 clad fuel rods; however, the configuration of the permanent alpha-tight cubicles, which are shielded with 4½-in. steel, allows sufficient flexibility to accommodate a variety of development work on a pilot-plant scale. The fabrication process is carried out remotely in these cubicles, with the exception of several gloved hand operations which occur where the dexterity required for manipulation exceeds that of the remote castle-type tongs. The fabrication equipment includes the powder-conditioning equipment, the vibratory compactor, the end-cap welding unit, and the gamma absorptiometer for density scanning. The facility was operated successfully during initial runs using depleted uranium as a substitute for U^{233}. (auth)

590 PLUTONIUM FUEL-CASTING FACILITY. L. G. Merker and C. H. Bloomster (General Electric Co., Richland, Wash.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 169-74(1963). (HW-SA-3029; CONF-187-10).

An induction-heated glove-box-enclosed casting facility was used at Hanford for the melting and casting of experimental plutonium-containing fuel alloys. The alloys are prepared in furnaces with removable clay-graphite crucibles, supported by rammed alumina containment shells. The furnaces, which have capacities of 25 and 50 pounds of aluminum, are tilted by rotary hydraulic actuators. Furnace power is supplied from a 30 kw, 4,200 cycles/sec motor generator set. The upper temperature limit of the furnaces is approximately 1500°C. A 300 ft^3 static-inert atmosphere glove box encloses the furnaces and is operated at a negative pressure of one inch of water. The glove box pressure is maintained by an automatic ventilation system which also provides for controlled purging and high emergency exhaust flows. A refrigerative cooling system makes possible the use of static-inert atmospheres during the melting and casting operations. Atmospheres of less than one percent oxygen can be maintained with purge rates of less than 20 ft^3/hr. The casting facility design allows easy conversion to a fully remote operation. Thermal reactor fuel materials containing a total of over 80 kilograms of plutonium were processed through the facility, including plutonium with Pu^{240} contents as high as 20%. (auth)

Properties and Structure

591 (AD-293487) THE ELECTRICAL BEHAVIOR OF REFRACTORY OXIDES. Seventh Quarterly Progress Report, January–March 1962. Robert W. Vest (Systems Research Labs., Inc., Dayton, Ohio). Apr. 16, 1962. Contract AF33(616)-7748. 8p.

The electric properties of pure zirconia and zirconia stabilized with calcia are being studied. The electrical behavior in the neighborhood of the monoclinic-tetragonal transformation is of particular interest. Work was initiated to investigate the influence of cation-cation interaction on electric conductivity in chromia-alumina solid solutions. (auth)

592 (AD-421756) DISPERSION-STRENGTHENED NICKEL-BASE ALLOYS. Progress Report No. 3, July 1 to August 30, 1963. A. S. Bufferd, R. C. Nelson, and N. J. Grant (New England Materials Lab., Inc., Medford, Mass.). Oct. 17, 1963. Contract N600(19)-59891. 9p.

A group of Nichrome-thoria alloys prepared by the thermal decomposition of thorium nitrate onto alloy powder indicated improved room temperature and equivalent high temperature tensile properties relative to the base composition. However, in the case of a modified Udimet 500 composition, the thoria-containing alloy showed lower properties than the base composition. In order to increase the amount of stored energy of deformation in the thoria-containing alloy, two alloys indicating a good degree of dispersion and moderate room temperature ductility were cold swaged 81% in reduction of area. These swaged alloys are presently being evaluated. (auth)

593 (ARL-63-170) RESEARCH ON THE THERMAL PROPERTIES OF ZIRCONIA. R. B. Burdick and W. R. Hoskyns (Materiadyne. Div. of Pfaulder Permutit, Inc., Alfred Station, N. Y.). May 17, 1963. Contract AF33(616)-8208. 81p.

Thermal expansion, thermal diffusivity, and elasticity measurements, over a range of temperatures, were made for zirconia bodies modified by additions of MgO, Al_2O_3, CeO_2, CaO, Ti, and Zr. The effects of the additives on these thermal properties of zirconia were demonstrated. Specimens of unstabilized monoclinic zirconia were prepared by hot pressing. The elastic moduli of these specimens were measured by a sonic method in the temperature range 25 to 1000°C. Application of mathematical expressions developed for the porosity dependence of elastic modulus of refractory oxides led to the calculation of Young's and shear moduli at zero porosity of this material in the specified temperature range. (auth)

594 (ASD-TDR-63-134) LUBRICATION BEHAVIOR OF LIQUID METALS. P. H. McDonald and J. A. Edwards (North Carolina State Coll., Raleigh). Jan. 1963. Contract AF33(657)-7635. 36p.

The lubrication behavior of liquid metals was studied. The objectives of the program were to study hydrodynamic bearing theory to determine the frictional characteristics, eccentricity, and load-carrying capacity of full journal bearings and to compare experimental data with analytical data and attempt to explain any discrepancies. Preliminary studies were conducted using Stoddard solvent as the lubricant. These studies suggested several modifications of the experimental apparatus and indicated some precautionary measures that must be taken to obtain reliable data. Bearing studies were made using NaK 78 as the lubricating medium. These were severely limited in speed due to a faulty turbine drive system. However, the

results indicated that the experimental apparatus is completely capable of accomplishing the stated objectives of the program if minor alterations are made to the turbine drive system. Modifications to eliminate the inadequacies of the turbine drive system were completed. In addition, other system modifications were made to facilitate future use of this equipment. This included the redesign of the bearing housing and liquid metal loop. The results obtained from an experimental investigation of the boundary lubrication behavior of NaK 78 are also discussed. (auth)

595 (ASD-TDR-63-413) CONTAMINATION EFFECTS ON LIQUID RUBIDIUM AND LIQUID LITHIUM SYSTEMS. W. D. Weatherford, Jr., Robert K. Johnston, M. L. Valtierra, and J. W. Rhoades (Southwest Research Inst., San Antonio). Apr. 1963. Contract AF33(657)-8657. 138p.

A research program directed toward the goal of developing an improved understanding of contamination effects on liquid rubidium and liquid lithium systems is described. Experimental measurements were conducted on the vapor pressure of pure rubidium, the melting point of pure and oxygen-contaminated rubidium, and the melting point of pure and nitrogen-contaminated lithium. The results of this phase of the experimental program confirmed recently reported rubidium vapor pressure data, established that oxygen contaminant exists in rubidium as soluble rubidium monoxide, and revealed that lithium nitride precipitates from supersaturated lithium at relatively slow rates. A capillary viscometer was designed and constructed, and extensive viscosity data were measured for pure and oxygen-contaminated rubidium from less than 200°F to about 1200°F. The results revealed that oxygen contamination of rubidium can lead to significant viscosity increases, particularly in the region of the normal melting point, but to a much less extent at higher temperatures. Pumping experiments in an isothermal loop revealed that oxygen contamination is quite deleterious to the electromagnetic pumping characteristics of rubidium. A new method was developed for the analysis of carbon in rubidium, and it was shown that the butyl bromide method for oxygen analysis is not applicable to rubidium. An alternate oxygen-analysis procedure for rubidium, based upon melting-point measurements, is proposed. On the basis of the results and observations of this program regarding handling problems and contamination effects entering into reliability considerations, it is concluded that rubidium appears more promising than lithium (and possibly than potassium and sodium) for use as a working fluid in space power plants. (auth)

596 (ATL-A-139) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Quarterly Progress Report No. 7, July–September 1963. K. E. Horton (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 29p. (EURAEC-841)

Testing of type 304-L austenitic stainless steel was completed. Thermal-stress-fatigue testing was started on ferritic pressure-vessel steel (ASTM type A302, Grade B), and work on this alloy is approximately half completed. Test specimens of type 403 martensitic stainless steel were machined and the heat treating schedule worked out in anticipation of testing this steel. The machining of test specimens of Croloy $2\frac{1}{4}$ steel was also started. (auth)

597 (BNL-825) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A BiMonthly Technical Progress Review, Vol. 1, No. 4. (Brookhaven National Lab., Upton, N. Y.). Aug. 1963. Contract AT-30-2-GEN-16. 41p. (BNL-PR-4)

Nineteen reviews are presented on physical properties and thermodynamics, fluid dynamics, heat transfer, material development and corrosion, instrumentation, component development, system studies, chemical analysis and chemistry, and fabrication techniques. (P.C.H.)

598 (CEA-2289) COMPORTEMENT AU CYCLAGE THERMIQUE ET STABILITE THERMIQUE DES ALLIAGES URANIUM–MOLYBDENE DE FAIBLES TENEURS EN MOLYBDENE. (Thermal Cycling Behavior and Thermal Stability of Uranium–Molybdenum Alloys of Low Molybdenum Content). J. Decours, B. Fabrique, and B. Peault (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 39p.

A study was made of the behavior during thermal cycling of as-cast U–Mo alloys whose molybdenum content varies from 0.5 to 3 per cent; results are given concerning grain stability during extended heat treatments and the effect of treatments combining protracted heating with thermal cycling. The thermal cycling treatments were carried out at 550, 575, 600, and 625°C for 1000 cycles; the protracted heating experiments were done at 550, 575, 600, and 625°C for 2000 hours (4000 hr at 625°C). The 0.5 per cent alloy resists much better to the thermal cycling than does the non-alloyed uranium. This resistance is, however, much lower than that of alloys containing over 1 per cent, even at 550°C; it improves after a heat treatment for grain refining. Alloys of over 1.1 per cent have a very good resistance to a cycling treatment even at 625°C, and this behavior improves with increasing concentrations up to 3 per cent. An increase in the temperature up to the β phase has few disadvantages provided that it is followed by rapid cooling (50 to 100°C/min). The α grain is fine, the γ phase is of the modular form, and the behavior during a thermal cycling treatment is satisfactory. If this cooling is slow (15°/hr) the α grain is coarse and cycling treatment behavior is identical to that of the 0.5 per cent alloy. The protracted heat treatments showed that the α grain exhibits satisfactory stability after 2000 hours at 575, 600 and 625°C, and after 4000 hours at 625°C. A heat cycling treatment carried out after these tests affects only very little the behavior of these alloys during cycling. (auth)

599 (CONF-276-1) DEFORMATION TWINNING IN FACE-CENTERED CUBIC METALS. Technical Report No. 1. J. A. Venables (Illinois. Univ., Urbana). Feb. 1963. Contract AT(11-1)-1198. 62p.

From Conference on Deformation Twinning, Gainesville, Fla., Mar. 1963.

A review is presented of work on deformation twinning in fcc metals. Experiments which prove the existence of deformation twins are described, the characteristics of the twins are reviewed, and the stresses required for their production are analyzed. The dislocation models which have been proposed to account for the nucleation of deformation twins are reviewed. A model is proposed for the propagation of twins. (D.L.C.)

600 (CRGM-1169) THE EFFECT OF HYDROGEN ON THE CREEP PROPERTIES OF ZIRCALOY-2. L. G. Bell (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1963. 22p. (AECL-1826)

Creep tests at 20,000 lb/in^2 and 300°F on annealed Zircaloy-2 showed that hydrogen concentrations up to 1075 ppm did not deteriorate the creep strength. Increasing the hydrogen content in fact decreased the amount of deforma-

tion obtained. Thermal cycles during the creep tests resulted in strain steps for those specimens with between 14 and 270 ppm hydrogen. Stress rupture tests at 300°C on notched specimens of annealed Zircaloy-2 containing 200 and 500 ppm hydrogen showed no tendency for delayed failure hydrogen embrittlement. (auth)

601 (DMIC-Memo-174) SOME DESIGN ASPECTS OF FRACTURE IN FLAT-SHEET SPECIMENS AND CYLINDRICAL PRESSURE VESSELS. L. R. Jackson, G. M. McClure, and J. A. Kasuba (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 9, 1963. Contract AF33(616)-7747. 23p. (AD-420376)

Structures designed by the aerospace industry often require the use of high-strength materials at high working loads. Such high-strength materials are often brittle in the sense that undetected small cracks may trigger into catastrophic lengths under loads that may be at design level or far under this level. When no initial cracks are present the material is satisfactory. It is necessary to know the size of the smallest crack that can be triggered into catastrophic growth by loads that might occur in service or in testing the components. Inspection would ensure that no cracks approaching critical length (or longer) are present. The results of flat-sheet tensile tests made at different laboratories were re-examined and put on a comparable basis. The materials represented are 7075-T6 clad, 2024-T3 clad, 2014-T6, and 2219-T87 aluminum alloys, and 17-7PH stainless steel. Curves are presented in a form usable by designers. One investigation was concerned with the fracture strength of cylindrical pressure vessels made from 2024-T3 and 7075-T6 aluminum alloys. The data from this investigation are put on the same basis as the flat-sheet data so that comparisons can be made. Conclusions from the data studied are presented and suggestions for additional testing are made. (auth)

602 (DP-819) EVALUATION OF FUSED UO_2. G. Rolland Cole (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Apr. 1963. Contract AT(07-2)-1. 39p.

The density and purity of fused UO_2 from several suppliers was evaluated. Densities of large pieces varied widely, but variations in pycnometer and bulk densities of crushed UO_2 powder were small. Average oxygen-to-uranium ratios ranged from 1.94 to 2.14. Impurities visible as microscopic inclusions were U_4O_9, metallic uranium, UC, and UN_2. The chief trace metallic contaminants were aluminum, iron, and silicon. Hydrogen, nitrogen, carbon monoxide, and carbon dioxide were evolved during vacuum extraction. (auth)

603 (JPL-TR-32-452) MECHANICAL AND THERMAL PROPERTIES OF HOT-PRESSED ZIRCONIUM CARBIDE TESTED TO 2600°C. Martin H. Leipold and Thomas H. Nielsen (California. Inst. of Tech., Pasadena. Jet Propulsion Lab.). Sept. 15, 1963. 17p.

Tensile, creep, thermal expansion, and modulus of elasticity data were determined for hot-pressed zirconium carbide. The material was relatively impure, containing 1 to 2% nitrogen and 1 to 2% free carbon. Tensile and creep properties, which were measured to 2600°C, indicated that above 2100°C the strength is 2,000 psi or lower and the elongation is 40% or greater, thus signifying little structural usefulness. It is proposed that results were influenced by the presence of impurity at the grain boundaries. Mean coefficient of thermal expansion of this zirconium carbide varied from 5.6×10^{-6} °C^{-1} (for 25 to 400°C) to 7.6×10^{-6} °C^{-1} (for 25 to 2300°C). Room-temperature modulus-of-elasticity values averaging 51.6×10^6 psi were obtained by dynamic methods. (auth)

604 (LADC-5626) URANIUM SHOCK PROPERTIES. J. W. Taylor (Los Alamos Scientific Lab., N. Mex.). Jan. 10, 1963. Contract [W-7405-eng-36]. 26p.

Three shots were fired in the study of the low-pressure hydrodynamic behavior of U. Plots of target free-surface velocity vs. time are presented for various target thicknesses and pressures. The free-surface deceleration and second gradual acceleration are discussed. The calculation of rarefaction sound speeds is considered. Results are reported of an experiment using the capacitor technique to observe a reflected shock in U. (D.L.C.)

605 (NCSC-2663-7) STUDY OF PHASE RELATIONSHIPS IN THE U–C–O SYSTEM. Progress Report, March 1962. Robert F. Stoops and John V. Hamme (North Carolina State Coll., Raleigh). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-2663. 22p. (EURAEC-290)

Uranium hydride was produced in quantity and was used as an ingredient of some of the compositions which were reacted. During this quarter, reactions were conducted at 1200, 1500, and 1800°C in both argon atmosphere and in vacuum. Phases with the uranium carbide structure were produced having lattice parameters as high as 4.974 and as low as 4.928 A. Considerable evidence was obtained that indicates that stoichiometric UC has a lattice parameter as high as 4.974 A. This is appreciably higher than the generally accepted value of 4.961 A. The lower lattice parameters usually found for UC are thought to result from the presence of nitrogen and/or oxygen and possibly from carbon deficiency. At the present time it appears that nitrogen content is the most important factor. Chemical analyses were made of several fired specimens and raw materials in an effort to determine the composition of the UC phase and factors controlling its composition. These chemical analyses consisted of determinations of carbon, oxygen and nitrogen. There appears to be a definite correlation between the nitrogen content and the lattice parameter of the UC phase; however, more data must be obtained to establish definitely the relationships among the oxygen, nitrogen, and carbon contents of UC and its lattice parameter. A new induction furnace has been designed and is being constructed to enable precise control of atmospheric conditions during firing. This control of the atmosphere in the reaction zone as well as control of impurities in the raw materials are essential before the solubility of oxygen and nitrogen in UC can be determined accurately. (auth)

606 (NCSC-2663-8) STUDY OF PHASE RELATIONSHIPS IN THE U–C–O SYSTEM. Progress Report, June 1962. Robert F. Stoops and John V. Hamme (North Carolina State Coll., Raleigh). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-2663. 14p. (EURAEC-356)

Various combinations of uranium chips, uranium hydride, carbon, uranium monocarbide, and uranium dioxide were reacted at several temperature levels in argon, vacuum, and nitrogen. Most of the UC phases produced in the argon atmospheres had lattice parameters of 4.964 or 4.965 Å. The lattice parameters of the UC phases produced in the vacuum firings were all 4.960 Å or lower. Reaction with nitrogen at 1200°C and atmospheric pressure yielded UN_2 when the starting materials were UC, UH_3, and U chips. There was no apparent reaction between nitrogen and UO_2 at 1200°C. A new furnace, designed for close control of the atmosphere, is being built and is almost complete. This new furnace will permit precise control of the partial pressures of gases such as oxygen and nitrogen during firings in vacuums or inert gas atmospheres. (auth)

607 (NOLTR-62-170) THE EQUILIBRIUM COMPOSITION AND THERMODYNAMIC PROPERTIES OF SODIUM VAPOR FROM 400° TO 10,000°K. Jacob Pomerantz and Robert Piacesi (Naval Ordnance Lab., White Oak, Silver Spring, Md.). Apr. 11, 1963. 20p. (AD-420172)

The thermodynamic properties and equilibrium composition of sodium vapor at densities from 10^{-6} to 1 amagat are presented for temperatures from 400 to 10,000°K. The calculations were made using the "ideal gas" approximation. Dissociation and ionization were taken into account, but no correction was made for intermolecular forces and for the lowering of the ionization potential. The method of making these calculations is described in detail. (auth)

608 (NRL-5988) HIGH-TEMPERATURE PROPERTIES OF SODIUM AND POTASSIUM. Tenth Progress Report for Period January 1 to March 31, 1963. C. T. Ewing, J. P. Stone, J. R. Spann, E. W. Steinkuller, and R. R. Miller (Naval Research Lab., Washington, D. C.). Aug. 5, 1963. 3p.

The experimental program to measure various thermophysical properties of sodium, potassium, and their vapors at elevated temperatures is continuing. Preliminary data for three PVT experiments with potassium to 2516°F are presented. (auth)

609 (TID-19548) APPLICATION OF COMPUTER METHODS TO THE ANALYSIS OF X-RAY SCATTERING FROM LIQUID METALS AND ALLOYS. Technical Report No. 3. H. Ocken (Yale Univ., New Haven. Hammond Metallurgical Lab.). Sept. 1963. Contract AT(30-1)-2560. 15p.

The radial distribution function, $4\pi r^2 \rho(r)$, a measure of the atomic arrangement in the liquid state, can be deduced from the experimentally measured x-ray scattering pattern of the liquid. A Fortran language program to perform the required calculations was compiled for use with an IBM 709 computer. The measured x-ray intensities are corrected for factors such as polarization and absorption, which are characteristic of the diffraction geometry. The resulting corrected intensities are then normalized to an absolute scale with the normalization constants determined by the high-angle and Norman methods. The absolute intensities, $I_{coh.}^{e.u.}$, are the basis for the calculation of $s \cdot i(s) = s \cdot [(I_{coh.}^{e.u.}/Nf^2) - 1]$ as a function of $s = 4\pi \sin\theta/\lambda$. Provision is included for the application of temperature damping factors of the form $\exp - (\alpha s^2)$ to the $s \cdot i(s)$ curve. The radial distribution function is evaluated after calculation of the Fourier sine coefficients of the $s \cdot i(s)$ curves. The Fourier coefficients are computed using a Simpson's rule subroutine. Input consists of the measured intensities and the corresponding values of the square of the atomic scattering factor, f^2, for equally spaced intervals of either s or 2θ. Output consists of the normalized intensities, the interference function, $I(s) = I_{coh.}^{e.u.}/Nf^2$, and the radial distribution function. (auth)

610 (UNC-5065) OUT-OF-PILE PROPERTIES OF MIXED URANIUM–PLUTONIUM CARBIDES. Progress Report, February 6, 1962–October 31, 1962. A. Strasser, D. Stahl (United Nuclear Corp. Development Div., White Plains, N. Y.), and K. Taylor (Carborundun Co. Research and Development Div., Niagara Falls, N. Y.). Sept. 18, 1963. Contract AT(30-1)-3254. 46p.

Fabrication studies to produce high density solid solutions of 80% UC–20% PuC, with reproducible structure, composition, and density, were completed. Two types of material were produced: $(U_{0.8}Pu_{0.2})C_{0.95}$, single-phase monocarbide pellets with average densities of 12.8 g/cm³ (94% of theoretical), sintered at 1950°C; and $(U_{0.8}Pu_{0.2})C_{0.95}$ + 0.1 wt % Ni sintering aid, major monocarbide and minor amount of sesquicarbide pellets, with average densities of 13.1 g/cm³ (96.5% of theoretical) sintered at 1550°C. Bar-shaped thermal expansion specimens were fabricated of UC, prior to fabrication of similar (U,Pu)C specimens. UC pellets were fabricated for electropolishing and liquid-metal bonding studies. Chemical analysis procedures were established, and checked, for plutonium, nitrogen, and oxygen. Chemical analysis procedures for carbon are being established. The experimental setups for the measurement of coefficient of thermal expansion, thermal stability, melting point, and fuel cladding compatibility were completed. Testing of thermal expansion, vapor pressure, and melting point standards was initiated. UC-liquid metal-tantalum compatibility tests were completed, and (U,Pu)C-liquid metal-tantalum compatibility specimens were prepared. These tests are to help in choosing a liquid-metal bond for the thermal conductivity test. The pre-installation tests for the safe performance of the high temperature measurements glove box were nearly completed. (auth)

611 (EURAEC-183) DIFFUSION OF RARE GASES IN SOLID BODIES. Quarterly Report, July 1–September 30, 1961. (Hahn-Meitner-Institut für Kernforschung, Berlin). Oct. 30, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 064-61-8-RDD. 10p. (A translation).

Xenon-133 losses were measured with UC, UC_{45}, and ThO_2. In all tests a compound Xe output was noted in the case of isothermic heating: an initially rapid output was followed by a slower process. In most cases the latter took the form of a linear flow of the F fragment yield as function of the time root, corresponding to the diffusion theory for relatively small F values. The Xe UC_{45} output was particularly high (25% in 24 hr at 900°C, 100% in 10 hr at 1500°C). Only a very small output of pure UC crystals was noted. One per cent of ThO_2 sintering bodies was noted at 900°C and 5% in 24 hr at 1300°C. (P.C.H.)

612 MECHANICAL TWINNING IN NICKEL. R. L. Nolder and G. Thomas (Univ. of California, Berkeley). Acta Met., 11: 994-5(1963). (UCRL-10646)

Investigations were made on the structural and mechanical properties of polycrystalline nickel deformed by shock and loading at room temperature as well as by tensile and compressive testing at various temperatures. The results suggest that mechanical twinning is favored by deformation at low temperatures or very high strain rates as well as by lowering stacking fault energy. (P.C.H.)

613 HOT-PRESSED LEAD ZIRCONATE-TITANATE-STANNATE CERAMICS. Gene H. Haertling (Sandia Lab., Albuquerque, N. Mex.). Am. Ceram. Soc. Bull., 42: 679-84(Nov. 1963).

An experimental procedure was developed to hot-press ceramic compositions under a wide range of temperature, time, and pressure conditions. A typical member of the lead zirconate–lead titanate–lead stannate family $Pb_{0.99}Nb_{0.22}(Zr_{0.68}Ti_{0.07}Sn_{0.25})_{0.98}O_3$ was chosen so that the effects of hot-pressing could be observed on ferroelectric properties as well as on other common physical properties of ceramics. Temperature was varied from 1050 to 1400°C, time (at temperature) from one minute to twelve hours, and pressure from 1500 to 12000 psi. Significant improvements in properties were noted for the hot-pressed specimens in comparison to the normally sintered material. Selection of the proper hot-pressing conditions resulted in a general improvement of all the commonly investigated ceramic properties, such as in-

creased remanent polarization, squareness ratio (P_r/R_p), planar coupling coefficient and translucency and a decreased coercive field. Dielectric constant, tangent δ and thermal expansion remained unchanged by hot-pressing. A study of the specimen microstructure showed that the final grain size could be varied by alteration of the hot-pressing conditions or by addition of small amounts of foreign ions to the base composition. Results indicated a dependence of remanent polarization on average grain size. Bulk densities as high as 99.75% theoretical were obtained by hot-pressing. (auth)

614 THE LOW TEMPERATURE RESISTIVITY OF β-PHASE PLUTONIUM. E. King and J. A. Lee (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Cryogenics, 3: 177-9(Sept. 1963).

The resistivity of metastable β-phase plutonium was measured at temperatures down to ~5°K. The resistivity shows anomalous behavior similar to that observed for both the α- and δ-phases in first rising with falling temperature and then dropping off rapidly. (C.E.S.)

615 STUDY OF STRUCTURAL TRANSFORMATIONS IN Ni–Cr–Nb ALLOYS. B. G. Livshits and V. B. Osvenskii. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Toplivo, No. 1, 139-46(1962).

Structural transformations in Ni–Cr–Nb alloys with a Nb content above the limit of its solubility in an Ni-base solid solution were studied in four alloys containing 9.53–10.5% Cr; 4.82, 7.85, 10.80, and 12.54% Nb; 0.018–0.23% C; remainder Ni, by means of electrical resistivity, hot hardness, microstructure, and lattice parameter measurements. Two distinct processes were found to occur; first, formation of the K-state (in the 400 to 800°C range), and second, precipitation of the Ni_3Nb phase from the solid solution (in the 700 to 1000°C range). K-state formation is shown by resistivity maxima at temperatures ranging from 550 to 625°C for alloys containing from 5–11% Nb. Heating at higher temperatures brings about destruction of the K-state and the onset of normal aging. The kinetics of the aging process was studied in a 13% Nb alloy. It was found that on aging at 1000°C, Ni_3Nb is precipitated as an acicular phase throughout the matrix, probably on the {111} planes. On aging at 850°C, however, the second phase is first seen as dispersed particles in grain boundary regions, which increase in size as the time of aging increases before the acicular pattern is observed throughout the matrix. At 700°C, even after 100 hours aging, the precipitate is still only visible in narrow grain boundary regions. It is suggested that at the lower aging temperatures, the precipitate within the grains is too fine to be seen under the optical microscope, although the increase in solid solution strength indicates that aging is taking place. Similar structures were obtained with 8% and 11% Nb alloys, although, as expected, the quantity of precipitate was smaller. (OTS)

616 BERYLLIUM AS A STRUCTURAL MATERIAL. HOW GREAT A DETERRENT IS ITS LACK OF DUCTILITY? S. Gelles, V. Nerses, and J. Siergiej (Nuclear Metals Inc., Concord, Mass.). J. Metals, 15: 843-8(Nov. 1963).

The chief limitation in using beryllium as a structural material, brittleness, is analyzed on the basis of the preferred orientation of slip planes of single crystals. Solutions to overcome beryllium's lack of ductility, alloying, texture and grain size control, and obtaining high-purity metal, are described and evaluated. Fabrication methods are listed and evaluated with specific regard to the brittleness problem of beryllium. (auth)

617 DIFFUSION TODAY. F. R. Winslow and K. H. Osthagen (Battelle Memorial Inst., Columbus, Ohio). J. Metals, 15: 855-60(Nov. 1963).

A review is presented on information published during 1962, both published papers and technical reports, in the field of diffusion in solids. Diffusion mechanisms, solutions of the diffusion equation, diffusion in ternary systems, self-diffusion, diffusion in pure metals and alloys, the effect of strain on diffusion, the effects of temperature and pressure gradients, interfacial diffusion, diffusion in nonmetals, and diffusion in liquids are all included. 138 references are included. (P.C.H.)

618 THE TERNARY SYSTEM: URANIUM–BORON–CARBON. L. Toth, N. Nowotny, F. Benesovsky, and E. Rudy (Universität, Vienna and Metallwerk Plansee AG, Reutte, Austria). Monatsh. Chem., 92: 794-802(1961). (In German)

Uranium–boron–carbon systems were studied roentgenographically (ca 60 tests) by means of heat-compressed samples. With the exception of U_2C_3 the occurrence of all alloys, such as UB_2, UB_4, UB_{12}, and UC, was confirmed. The structures are given and the measured values of their lattice parameters are compared with literature values. In the phase diagram area for the pseudobinary intercept, UB_2–UC, the prevailing crystal form was the ternary phase, with the approximate formula UBC. This phase exists in equilibrium with UC, UC_2, C, UB_2, and UB_4. The crystal form has a rather wide range of homogeneity. The UBC phase crystallizes in the spatial group D_{2h}^{17}. Its structure is similar to the CrB or ZrSi type. The position of the U atom has been exactly determined ($y_U = 0.132$ in 4c). The relative positions of the B and C atoms in this compound are suggested by comparison with other crystal types. The structure of UBC appears to be closely similar to the structural formation of an alloy, ThBC, which is derived from at least four ternary crystal types in the system, Th–B–C. (BBB)

619 STUDIES OF THE TERNARY SYSTEM THORIUM–URANIUM–BORON. L. E. Toth, H. Nowotny, F. Benesovsky, and E. Rudy (Universität, Vienna and Metallwerk Plansee AG, Reutte, Austria). Monatsh. Chem., 92: 945-8(1961). (In German)

Th–U–B systems were studied roentgenographically by means of samples prepared by heat compression and by combustion under argon. Their phase distribution was determined at 800 and 1500°C. The phases ThB_4 and ThB_6 were confirmed. The measured lattice parameters of these phases agreed closely with values quoted from the literature. The tetraborides ThB_4 and UB_4 form unbroken series of mixtures at both 800 and 1500°C, but there were no intermediate phases in the U–Th system. Although no samples could be obtained it could be determined that a triphasic alloy was formed from the constituents of the type Th–U–UB_2. All of the other crystal forms indicated by the phase diagram possess only very limited solubility properties. (BBB)

620 THE TERNARY SYSTEM THORIUM–BORON–CARBON. L. E. Toth, F. Benesovsky, H. Nowotny, and E. Rudy (Universität, Vienna and Metallwerk Plansee AG, Reutte, Austria). Monatsh. Chem., 92: 956-60(1961). (In German)

Th–B–C systems were studied roentgenographically by means of sintered and molten samples. About 100 samples were prepared. In the phase diagram area represented by Th–ThC–ThB_4 the ignition temperature was between 800 and 1000°C (argon, 5 hr), and in the other areas it was about 1400° for 15 hr. As in the U–B–C system the binary crystal types ThC, ThC_2, ThB_4, ThB_6, and B_4C were detected. The possible transition of ThC to ThC_2 (a high temperature form) was not studied in detail. Within the temperature range where Th, B, and C were studied, Th carbide and

boride were not mutually soluble. However, the marked tendency for compound formation resulted in four crystal forms, ThB_2C, ThBC, $ThBC_2$, and Th_2BC_2. The structure of ThB_2C is suggested tentatively to be of a C32 hexagonal type. Sintered samples of ThBC showed a complex roentgenographic pattern which suggested a H-stabilized phase. $ThBC_2$ is stable in air, but Th_2BC_2, like ThC_2, decomposes in air, suggesting a close similarity between these two alloys. (BBB)

621 STUDIES OF THE SYSTEM THORIUM–ZIRCONIUM–CARBON. E. Rudy and F. Benesovsky (Metallwerk Plansee AG, Reutte, Austria). Monatsh. Chem., 93: 1279-83(1962). (In German)

Th–Zr–C systems, prepared by sintering under pressure, vacuum cooling, and arc fusion, were studied roentgenographically and metallographically. A phase distribution was carried out at 1100 and 1550°C. Alloys of the type Th–Zr–ZrC–ThC were ignited for 40 hr at 1100°C and others of the type ThC–ZrC–C were ignited at 1550°C for the same time period. The ~60 powdered alloys were examined with the Cu–K_α band. Ternary alloys of the Zr–C system appeared to be present. The solubility of Th for C was about 6 at.% C, in agreement with values previously reported. The monocarbide had a range from 38–50 at.%. Thorium–zirconium samples ignited for 40 hr at 1100°C or prepared by arc fusion separated into two phases during cooling and could not be stabilized; ThC_2 and ThC form quasibinary eutectic mixtures with ZrC at both 1100 and 1550°C. No appreciable metal exchanges (less than 2 mole % ZrC for ThC and none for ThC_2) take place in the carbide phases. (BBB)

622 EFFECTS OF HIGH REFRACTORY OXIDES ON THE THERMOELECTROMOTIVE FORCE IN W, Mo, AND Ta IN A VACUUM AT 1500°C. V. I. Ivanov, G. E. Pletenetskii, and E. P. Nechiporenko. Ogneupory, No. 7, 327-31(1963). (In Russian)

It is shown that BeO, Al_2O_3, and MgO do not effect the thermoelectromotive force of tungsten, while ZrO_2 reactions with W at 1500°C alter its initial thermoelectromotive force. The thermoelectromotive force of Mo is not effected by MgO, Al_2O_3, ZrO_2 and BeO. Tantalum thermoelectromotive force is considerably changed in heated Al_2O_3, BeO, MgO, and ZrO_2 powders. (R.V.J.)

623 PHASE DIAGRAMS OF CALCIUM AND STRONTIUM AT HIGH PRESSURES. A. Jayaraman, W. Klement, Jr., and G. C. Kennedy (Univ. of California, Los Angeles). Phys. Rev., 132: 1620-4(Nov. 15, 1963).

The melting temperatures for both Ca and Sr increase rapidly with pressure, reaching nearly 1200°C at 40 kbar. The only solid-solid transition in Ca below 35 kbar is that between the body-centered cubic and face-centered cubic polymorphs; the slope of the phase boundary is about 3.3°C/kbar. The phase boundary between the homologous Sr polymorphs has an initial slope of about –10°C/kbar becoming much steeper at higher pressures. Also, the hysteresis associated with the transition is a function of pressure and becomes very large above 22 kbar. The face-centered cubic Sr shows a large increase in resistance with pressure and a negative temperature coefficient of resistance prior to the polymorphic transition. The resistance discontinuity for the fcc-bcc transformation is a sharp increase at lower pressures, which progressively decreases in magnitude and sharpness and reverses sign at the higher pressures. (auth)

624 MOBILITY ACTIVATION ENERGY OF Nb AND C IN METALLIC NIOBIUM AND ITS CARBIDES. P. V. Geld and V. D. Lyubimov (Inst. of Chemistry, Ural Branch of the Academy of Sciences, USSR). Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 4, 76-8(July-Aug. 1963). (In Russian)

The diffusion processes of niobium and carbon in metallic niobium and its carbides were studied. It is shown that the activation energy of the diffusion process of niobium in carbide is 35 pC lower than in metal, while the activation energy of the diffusion process of carbon is about the same in metals and in carbides of various composition. (auth)

625 AN INVESTIGATION OF THE ZIRCONIUM–NIOBIUM–MOLYBDENUM SYSTEM. Yotaro Murakami, Toshio Enjyo, and Hiroyuki Yoshida. Tech. Rept. Eng. Res. Inst., Kyoto Univ., 13: No. 5, 1-83(Mar. 1963).

An investigation of the zirconium–niobium–molybdenum ternary alloys showed that the peritectic point of liquid + Mo $\rightleftharpoons$ $ZrMo_2$ at the composition of 32.2% zirconium at 1880°C probably decreases its temperature gradually with increasing niobium content and coincides with the eutectic point of liquid $\rightleftharpoons$ β solid solution + $ZrMo_2$ at the composition of 69% zirconium. The exact point where the peritectic reaction changes to the eutectic reaction could not be determined. No ternary compound may exist in the zirconium–niobium–molybdenum ternary system. A ternary eutectoid reaction was found to occur at about 535°C in the system. The non-variant point is assumed to be probably in the vicinity of 13% niobium and 8% molybdenum. The systematic equilibrium diagram obtained from the results and theoretical consideration is illustrated. (P.C.H.)

626 SURFACE ENERGY AND HEAT OF SUBLIMATION OF RARE-EARTH METALS. S. N. Zadumkin and B. S. Tambiev. Uch. Zap., Kabardino-Balkarsk. Gos. Univ., No. 13, 46-9(1961).

Results of calculating σ and $d\sigma/dT$ for all the 14 lanthanides by the approximate method, which connects σ with the head of sublimation and melting of metal and with the short-range order in the melt, are presented. The method is based on the distribution of the metal energy over the bonds of close neighbors, which are considered to be the octahedral positions in the cubic lattice and the tetrahedral positions in the hexagonal compact lattice. It was established that σ for different lanthanides varies within a range of 250 to 988 erg/cm^2, and $d\sigma/dT$ from 0.041 to 0.99; the results of calculations are in agreement with the periodic course of other physical and chemical constants as a function of the atomic number of the same elements. It is pointed out that changes of the calculated values obtained may occur on the basis of structure refinement of high-temperature lanthanide modification. (Referativnyy zhurnal, Metallurgiya, No. 6, 1962)

627 GRAPHITE. H. Bridge and J. S. Nairn. p.171-220 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The properties of graphite for use as a moderator in gas-cooled reactors are presented. Irradiation damage and the carbon dioxide–graphite and air–graphite reactions are also discussed. (C.E.S.)

628 ADSORPTION AND DESORPTION OF WATER FILMS ON GRAPHITE SURFACES. G. L. Montet (Argonne National Lab., Ill.). p.116-19 on "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

The presence of water as a film on the surface of graphite markedly affects the rate of oxidation of graphite. This observation led to an attempt to evaluate the properties of the surface films by using a radioactive tracer technique. It was found that water films on graphite will readily ex-

change with tritium gas (T_2 or HT) and with tritiated water vapor. The absorptive properties of the films may then be studied using the radioactivity to detect the presence of a film. Such studies were made using the surfaces of graphite single crystals and those of spectroscopic graphite. The films are strongly held but may be removed by heating to ~900°C. This treatment is sufficient to remove all of the tritiated water from single crystals of graphite; however, water is still held in the deep pores of artificial graphite. (auth)

629 THE ADSORPTION OF IODINE BY GRAPHITE. P. Connor, J. B. Lewis, and W. J. Thomas (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.120-4 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

A description is given of a gravimetric study of the adsorption of iodine by reactor grade graphite at temperatures of 85, 150, 200, and 400°C over the pressure range of 0.3 to 500 mm Hg and of desorption from the same specimens at temperatures up to 700°C. Iodine is chemisorbed by graphite at temperatures equal to or above 200°C and the rate of adsorption follows the Elovich equation. No interlamellar compound formation occurred nor were any slow absorption effects observed. Adsorption-desorption experiments with iodine and hydrogen indicate that a surface reaction occurs between iodine and hydrogen atoms and this is likely to play a significant role in the mechanism by which iodine is adsorbed by graphite. (auth)

630 THE EFFECT OF GASIFICATION BY CARBON DIOXIDE ON THE PORE STRUCTURE OF GRAPHITE. J. Butcher and D. M. Grove (Queen Mary Coll., London). p.205-14 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Samples of reactor grade graphite, and of a more impermeable graphite, were gasified in successive stages to a few per cent burn-off by carbon dioxide at ca 700°C. To ensure that the reaction occurred uniformly, a small pressure head was applied and the carbon dioxide flowed through a thin layer of the sample. The extent of gasification was determined by chemical estimation of the carbon monoxide produced. The pore structure of the graphite after different stages of gasification was investigated by measurements of helium density, bulk density, B.E.T. surface area, permeability, and pore size distribution. The surface area and permeability first increased rapidly with gasification and then more slowly. For the more impermeable graphite, the initial increase was less rapid. The results were interpreted in terms of the opening up of closed pores, and of the greater reactivity of the binder material compared with the filler. The importance of using several methods to investigate pore structure is stressed. (auth)

631 PERMEABILITY TO GAS OF NUCLEAR GRAPHITE—STUDY OF THE POROUS STRUCTURE BY POROSIMETRY WITH MERCURY. J. Rappeneau, M. Bocquet, A. Fillatre, and J. C. Trutt (Centre d'Etudes Nucléaires, Saclay, France). p.335-53 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962. (In French)

Equipment was developed to determine the permeability and porosity of graphite. A study of the permeability of the gas was conducted with the aid of two devices based on the principle of establishing a regime of stationary flow across a partition of graphite. The first apparatus gives the possibility of studying the permeability under conditions similar to those existing in the pile: absolute pressure 2-25 kg cm^{-2} and pressure drop Δp of 1 kg cm^{-2}. Under the conditions of this regime, flow is more or less turbulent. The second apparatus functioning at some low pressure (0-1 kg cm^{-2}) permits a flow regime exempt from turbulence to be obtained; slip flow type. Measurements of the coefficient of permeability, K, of different graphites, made with the two devices, permitted the influence of several fabrication parameters to be shown on the permeability: granulometric, and impregnation process. The coefficient of permeability, K, can be joined to the characteristics of the gaseous flow and to the porous structure in determining the medium hydraulic region, m, and the tortuosity coefficient, Lc/L. A mercury porosimeter was used to study the porous structure of graphite. The mercury pressure is increased step-wise from 6 to 1000 kg cm^{-2} thus yielding the complete distribution of pores from 92 μ to 75 A, as well as certain physical characteristics. The distribution of the pore radii of different nuclear graphites was established, along with the influence of the fabrication parameters. Satisfactory accord was found between the results obtained. (P.C.H.)

632 THE MIGRATION OF FISSION PRODUCTS IN ARTIFICIAL GRAPHITE. J. Bromley and N. R. Large (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.365-76 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Graphite was irradiated in contact with uranium–graphite compacts and the distribution of fission products in the graphite was studied. Fission products that entered the graphite by recoil from the surface of the compacts were much less mobile than those that reached it by migration from the interior. Cesium, strontium, and barium were found to be much more mobile than cerium, zirconium, and ruthenium, and among the rare earth elements mobility was found to increase with increasing atomic number. The amounts of fission products found in the graphite depend principally on the rates of release from the grains or crystallites into which they recoil. In-pore diffusion constants for cesium, strontium, and barium were measured for four different graphites at temperatures in the range 500–1100°C. The method involved the determination of concentration profiles after diffusion into graphite blocks from adjacent thin discs of graphite impregnated with nitrate solutions at trace concentration levels. Activation energies for the diffusion of the elements fall between 7 and 20 kcal. The diffusion constants fall in the range 10^{-4}–10^{-7} cm^2/sec. It was concluded that migration of fission products through graphite takes place mainly by an activated surface process. (auth)

633 PROPERTIES OF FUELED GRAPHITE. R. A. Reuter and D. D. Johnson (National Carbon Co., Fostoria, Ohio). p.377-83 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Fueled graphite compacts were prepared using the admixture technique. The choice between type of fuel to be admixed and dispersed in graphite is primarily dependent upon reactor operating conditions. Factors involved in the choice of various chemical forms of fuel are discussed. The geometry and fuel loading are factors that determine whether the elements will be molded or extruded. Physical properties typical of both forming processes are discussed. Limited irradiation data illustrate the stability of graphite fuel elements. (auth)

634 THORIUM OXIDE INFILTRATION OF GRAPHITE SPHERES. Frank Rusinko, Jr., and W. E. Parker (Speer Carbon Co., Niagara Falls, N. Y.). p.384-91 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

The process of infiltrating graphite spheres with thorium

nitrate solutions followed by conversion to the oxide was studied. The principal processing variables of infiltration and denitration were evaluated and a procedure established. Target loadings of 30–45 g of thorium oxide can be attained in seven infiltration cycles. Radial distribution of deposited thorium oxide was found to be reasonably uniform. (auth)

635 NEUTRON-DIFFRACTION STUDIES OF THE STRUCTURE OF CARBON BLACKS. A. E. Austin and E. Adelson (Battelle Memorial Inst., Columbus, Ohio). p.485-91 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

A study was made by neutron diffraction of carbon blacks with varying hydrogen content. The data were compared with those from x-ray diffraction and also with computed neutron scattering from graphitic layers having bonded hydrogen. The results indicate that hydrogen in carbon blacks may be bonded to edge atoms of the graphitic layers and contribute to the coherent scattering. The partial removal of hydrogen by heat treatment produces a modification of the neutron-diffraction pattern approaching that of just graphitic layers. Both hydrogen and tetrahedrally coordinated carbon can contribute to broadening observed in higher order layer reflections. (auth)

636 THE STRENGTH OF GRAPHITE. H. H. W. Losty and J. S. Orchard (General Electric Co., Wembley, Eng.). p.519-32 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

The elastic properties of a variety of graphites were studied up to the ultimate stress. Measurements included the stress-strain behavior in tension, compression, and flexure. Room temperature permanent sets and the lateral strains defined by Poisson's Ratio were also measured. The materials used in the measurements included a variety of commercial extruded graphites and a large number of moulded samples prepared by two distinct methods of mixing and firing. The effects of heat treatment, impregnation and neutron irradiation were used to introduce further variations in the properties measured. The discussion includes a comparison of the variabilities of the destructive and non-destructive tests. From this, and other evidence relationships between modulus and strength are demonstrated. An attempt was made to define the possible modes of failure of graphite under stress. (auth)

637 DETERMINATION OF THE THERMAL DIFFUSIVITY FOR POLYCRYSTALLINE GRAPHITES AT HIGH TEMPERATURE. N. H. Juul (Univ. of Buffalo). p.533-46 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Two methods were developed and employed for determining the thermal diffusivity of graphites. The first method utilizes a steady sinusoidal heat input at one end of a thin walled tube, which is placed in a uniformly heated space. Measurements of the longitudinal diffusivity were performed in the temperature range 120–650°C. In the second method a rod is initially heated to equilibrium conditions by passing an electrical current through it and then permitted to cool by radiation and convection. Using this method the transverse thermal diffusivity of several different graphites was measured over the temperature range 750–2800°C. The reproducibility appears to be reasonably good if oxidation of the surface is avoided. The thermal diffusivity values obtained by the use of the second method were compared with values calculated from K/dc where K is the thermal conductivity. It was found that the values for the measured thermal diffusivity are up to about 30% lower than the corresponding values calculated from the thermal conductivity. A satisfactory explanation of at least a large part of the discrepancy was not found. (auth)

638 PROPERTIES OF HIGH DENSITY, RECRYSTALLIZED GRAPHITE. R. M. Bushong and E. A. Neel (National Carbon Co., Lawrenceburg, Tenn.). p.595-9 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Physical and thermal properties are reported for several types of graphite, including National Carbon Company grades ATJ and ZT, pyrolytic, and single crystal graphite. Graphites compared cover a density range of 1.73 to 2.26 g/cm^3. The effects of temperature (range 0–3000°C) on properties are discussed. The high density, recrystallized graphites (ZT) are intermediate in properties between grades ATJ and the pyrolytic and single crystal graphites. (auth)

639 ULTRASONIC INSPECTION OF IRRADIATED FUEL RODS. T. G. Lambert (General Electric Co., San Jose, Calif.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 255-65(1963).

An immersion ultrasonic testing facility in use at the General Electric Radioactive Materials Laboratory, Vallecitos Atomic Laboratory, Pleasanton, California for examining irradiated fuel rods is described. The tester uses pulse echo ultrasonics to study the condition of irradiated fuel cladding. Cracks as small as 5% of the wall thickness may be detected under favorable conditions, but the presence of scratches, gouges and scale may limit the test to cracks 30% of the wall or greater. The tester is composed of a stainless steel tank in which the fuel rod is immersed, handling fixtures which position the test head over the appropriate area of the rod, and associated electronic circuitry necessary to the test. All equipment was designed especially for in-cell use, with most setup and maintenance done remotely by manipulators. A year's experience showed the tester to be a valuable aid in the examination of irradiated fuel. Fuel clad defects visually undetectable were detected by the tester and later confirmed by metallographic examination. (auth)

640 DIMENSIONAL MEASUREMENTS ON IRRADIATED FUEL USING DIFFERENTIAL TRANSFORMER INSTRUMENTATION. Z. Domaratzki, J. Christie, and A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ontario). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 311-21(1963).

Equipment was developed to give a continuous record of the dimensions of irradiated fuel elements and multielement fuel bundles. The primary measuring device is a linear variable differential transformer acting as a displacement-voltage transducer which feeds into a chart recorder. The transducer is mounted in a suitable fixture which enables centering on the fuel by a hand-driven cross feed and longitudinal movement along the fuel by a motor-driven lead screw. All measurements are made with the fuel in a vertical position. Interchangeable fuel supports permit measurements on fuel up to 3.25 inches OD and up to 8 feet long. Measurements obtained include diameters, profiles, and extent of local deformations. Accuracies are generally better than ±0.002 in. A separate unit enables measurement of element lengths and end plate profiles. Reproducibility of individual dimensions, ease of remote operation, and rapid assessment of results are the chief advantages of the apparatus. (auth)

641 PHYSICAL AND MECHANICAL PROPERTIES TESTING CELL. Harvey A. Taylor (General Electric Co., Richland, Wash.), Donald J. Meyers, and Joseph E. Corri-

gan. Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 423-36(1963).

The Physical and Mechanical Properties Testing Cell is located in the Radiometallurgy Laboratory of Hanford Laboratories. The cell provides facilities for examining and testing radioactive reactor components and irradiated structural materials. The cell houses equipment to measure such mechanical properties as tensile, compressive, flexure, impact, fatigue, and shear strength; and physical properties such as coefficient of linear thermal expansion. (auth)

Radiation Effects

642 (AD-297512) [RADIATION EFFECTS ON PREAMPLIFIER MATERIALS]. Progress Report, February 1963. (Litton Systems, Inc., Woodland Hills, Calif.). Contract AF33(657)-10548. 10p.

The redesign of the gyro preamplifier test specimens and the experimental test plan for studying radiation effects on the test specimens are discussed. Dosimetry requirements are studied and a preliminary analysis of the effect of neutron and gamma spectra on damage has commenced. (N.W.R.)

643 (BMI-1638) RADIATION STABILITY OF URANIUM MONONITRIDE. Richard A. Wullaert, John F. Lagedrost, Josef Bugl, and John E. Gates (Battelle Memorial Inst., Columbus, Ohio). June 28, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 35p. (EURAEC-760)

Bare and stainless steel-clad isostatically hot-pressed uranium mononitride pellets were irradiated to burnups up to 3.8 at.% of the uranium at temperatures as high as 615°C (surface) and 1260°C (center line) in NaK-filled capsules. The irradiation parameters were selected to permit an evaluation of the effect of both fuel burnup and hydrogen formation [from the $N^{14}(n,p)C^{14}$ reaction] on the stability of UN. Results of the irradiation indicated that hydrogen produced by the (n,p) reaction (~15 ppm) was not detrimental to the UN at these temperatures. Irradiated UN exhibited good dimensional stability, low fission gas release (<0.6 per cent), and 25 per cent increase in hardness. Only the most stringent temperatures and burnup conditions produced definite microstructural changes in the UN. Some grain growth occurred, and a white second phase precipitated near the UN-cladding interface. There was no attack of the UN by NaK during irradiation. In general, uranium mononitride showed excellent radiation stability. (auth)

644 (CONF-39-99) PRELIMINARY RESULTS OF RADIATION DAMAGE STUDIES. A. D. Rossin (Argonne National Lab., Ill.). May 28, 1963. Contract [W-31-109-eng-38]. 26p.

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

Although much dosimetry data remain to be analyzed, a preliminary correlation of damage rates in different reactors is reported. Data from two positions in CP-5 appear to correlate well. Impact-test data from EBR-I are smoothed in a novel way, and the results form a curve to which a straight-line approximation is made. The correlation is improved when an allowance for thermal neutrons is added. The RDU (Radiation Damage Unit) to measure fast neutron exposure is introduced. The RDU rate can be determined in any reactor where the fast neutron spectrum and absolute magnitude of the flux are known. One value of the activation rate of a threshold detector is sufficient to determine the absolute magnitude of the flux. A new table of multigroup cross sections is included. A remotely operated hydraulic shear has been built to cut small pieces from irradiated steel specimens. The induced Mn^{54} activity at each notch will be counted to obtain the exact exposure of the metal involved in any fracture region. Ambiguities that may result from the use of the $\varphi > 1$ Mev notation for dose measurement are discussed. The RDU gets away from these problems, even though its accuracy is limited to the extent that good detailed cross section data are available. (auth)

645 (CRFD-1166) THE THERMAL CONDUCTIVITY OF COLUMNAR GRAINS IN IRRADIATED UO_2 FUEL ELEMENTS (IRRADIATION TESTS X-255 AND X-227). M. J. Notley (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1963. 26p. (AECL-1822)

An irradiation experiment was performed to determine whether the columnar (essentially single-crystal) grains grown in UO_2 fuel elements under irradiation at high heat ratings showed an enhanced thermal conductivity. No indication was found of any alteration in thermal conductivity within the limits of error of the experiment. Although this does not exclude the possibility that enhanced conductivity can occur in uranium dioxide, it indicates that it is not necessarily a property of single crystal material. Further information was obtained on the dependence of diametral expansions of Zircaloy-sheathed UO_2 fuel elements on heat rating, which confirms that the metallographic identification of the extent of central melting is substantially correct. However there are indications that metallographic examination may underestimate the extent of central melting in a fuel element that has undergone prolonged low power operation subsequent to the time at which melting was a maximum. (auth)

646 (D2-9878-3) CONTRIBUTIONS TO THE STATE-OF-THE-ART OF TRANSIENT RADIATION EFFECTS IN ELECTRONIC PARTS AND MATERIALS. VOLUME 2. (Boeing Co., Seattle). [1962]. 255p.

Five sections are presented on topics related to transient radiation effects in electronic parts and materials. Three of the sections deal with radiation effects on properties, while the other two treat the production of Compton electrons and ion pairs by pulsed radiation. Separate abstracts were prepared for four of the sections; the remaining section was previously abstracted in NSA. (D.L.C.)

For abstracts of individual sections see: 647, 648, 680, and 681.

647 (D2-9878-3(Sect.E)) NEUTRON-GAMMA RATIO DEPENDENCE OF TRANSIENT RADIATION EFFECTS IN ELECTRONIC PARTS. G. L. Keister (Boeing Co., Seattle). 27p.

A series of experiments was performed using shields to vary the neutron-to-gamma ratio of the Kukla spectrum in an attempt to determine the ionization efficiency of neutrons. Results were obtained using a Mylar capacitor and coaxial cable which, when compared with theoretical prediction, tended to substantiate the predicted values of ionization which are calculated in Sec. I of this report. (auth)

648 (D2-9878-3(Sect.F)) THE RESPONSE OF p-n-p-n TRANSISTOR SWITCHES TO PULSED NUCLEAR RADIATION. H. J. Lubatti and G. L. Keister (Boeing Co., Seattle). 23p.

Silicon p-n-p-n structures in the form of GE 2NC35A controlled rectifiers were exposed to radiation pulses from the Godiva III pulsed reactor and the Boeing flash x ray. The turn-on characteristics of these devices were

studied as a function of applied cathode voltage, radiation rate, and total dose. It was determined that turn-on is controlled by a critical radiation dose being received in a time short compared to the device response time. The critical dose decreases as the applied cathode voltage is increased, but for applied cathode voltages of 20 to 50 volts, the critical dose falls within the range of from 1 to 10 roentgens if it is delivered within 0.2 to 1 μsec. (auth)

649 (EURAEC-371) SWELLING OF URANIUM. Final Report No. 1, September 1, 1960 and March 31, 1962. (Mol, Belgium. Centre d'Etude de l'Energie Nucleaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 022-60-10 RDB. 27p.

The effects of radiation on structure of uranium, chromium–uranium alloy, and platinum are investigated. The following problems are analyzed: the dislocation configuration of uranium, the nature of the nucleation sites of the bubbles, the mechanism of growth of the bubbles, the growth kinetics of the bubbles, the influence of thermal cycling, and the effect of preirradiation heat treatment. (N.W.R.)

650 (EURAEC-390) IRRADIATION OF STEEL SAMPLES IN EL-3 AT VARIOUS TEMPERATURES, AND TESTING AFTER IRRADIATION. (France. Commissariat a l'Energie Atomique, Paris). [1961]. Work Performed under United States–Euratom Joint Research and Development Program. 1p.

The irradiation conditions (integrated flux and temperature) are tabulated for five of six assemblies, each assembly consisting of 100 tensile-test specimens. (D.L.C.)

651 (FZK-147) INVESTIGATION OF COMBINED EFFECTS OF RADIATION AND VACUUM ON ENGINEERING MATERIALS. Second Quarterly Progress Report, February 9–May 8, 1962. E. E. Kerlin and E. T. Smith (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). June 4, 1962. Contract NAS8-2450. 116p. (N62-15057)

The effects of the combined environment of nuclear radiation and high vacuum on a selected number of engineering materials is being investigated. The environment is designed to approximate that which would be experienced by the component parts of a nuclear-powered spacecraft during the flight. The materials selected for testing are representative of those most likely to be used in a spacecraft of this type. The experiment will utilize two vacuum test chambers. Results are presented of the following investigations: radioinduced gassing rates in certain organics; heat-transfer calculation in a vacuum environment; and calibration of the pilot model of the special weight-loss equipment. (auth)

652 (FZK-163) MEASURED EFFECTS OF THE VARIOUS COMBINATIONS OF NUCLEAR RADIATION, VACUUM, AND CRYOTEMPERATURES ON ENGINEERING MATERIALS. Quarterly Progress Report, November 9, 1962–February 28, 1963. E. E. Kerlin and E. T. Smith (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Mar. 15, 1963. Contract NAS8-2450(Mod.3). 97p. (N63-16677)

The experimental facilities were decontaminated, repaired and modified; and a thermal conductivity testing apparatus was designed. Also, materials to be tested were selected and ordered. The materials selected and the tests to be performed are listed, and experimental apparatus and procedures are described. The results of various tests performed previously on a variety of materials are also discussed. (D.C.W.)

653 (GA-4282) IRRADIATION OF EXPERIMENTAL GRAPHITES. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). June 17, 1963. Contract AT (04-3)-167. 8p. (CONF-272-1)

From Libby Cockcroft Graphite Radiation Meeting, Richland, Wash., June 1963.

A number of experimental graphites prepared as possible fuel matrix materials by hot molding or hot working were irradiated at 450 and 1400°C to ~2×10^{21} nvt. A NPR needle coke graphite was included as a reference. The radiation effects on the dimensions and crystal structures of the fuel matrix, NPR reference, and AGOT control are compared. Thermal conductivity was also measured on the unirradiated and irradiated NPR graphite. (D.L.C.)

654 (GEAP-3771-10) HIGH PERFORMANCE UO_2 PROGRAM. Quarterly Progress Report No. 10, July–September 1963. B. Weidenbaum (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 15, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (04-3)-189. 73p. (EURAEC-847)

In direct measurement of fission gas pressure in UO_2, all phases of the post-irradiation examination of two rods from the group of 5 irradiated rods were completed. Three irradiations were conducted in the GETR Pressurized Water Loop. A reappraisal of the hazards associated with the loop was conducted. The failed rod in fuel assembly EPT-12C had a longitudinal split, 2.5-cm long, in the peak heat flux zone of the rod. Although the rod was irradiated to a burnup of more than 1.6×10^{20} fissions/cm^3, hardness tests indicated that no loss in ductility was suffered by the cladding. A second rod in the EPT-12C assembly had a diameter increase of 0.48 mm and was slightly bowed. A powder fuel assembly was irradiated to an average burnup of 2048 Mwd/T with a maximum heat flux of 1.45×10^6 Btu/hr-ft^2. A series of 5 groups of pellets were prepared for isothermal grain growth experiments. In the course of melting experiments, under a severe temperature gradient, a two-phase structure was found in the UO_2 structure as a result of the reaction between UO_2 and the alumina cladding. Heat treatments carried out at central temperatures just below the UO_2 melting point, with two different temperature gradients, produced structures that are indistinguishable from short-term-irradiated UO_2 specimens. (M.C.G.)

655 (HW-SA-2874) THERMAL CONDUCTIVITY OF IRRADIATED GRAPHITE BY A RAPID THERMAL-PULSE METHOD. D. E. Baker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 28, 1963. Contract AT(45-1)-1350. 13p.

A convenient and rapid method of measuring thermal conductivity by a thermal-pulse method was adapted to the measurement of irradiated graphite. Samples were irradiated at 650 ± 10°C to greater than 10^{21} nvt (E > 0.18 Mev). Post-irradiation measurements by the thermal-pulse method yielded values of thermal diffusivity from which the thermal conductivity was calculated. The apparatus is described, and thermal conductivity data are presented for three types of graphite in the temperature range 25 to 550°C. An example of the annealing of radiation damage in CSF graphite irradiated at 75°C is given. (auth)

656 (NARF-63-7T) EFFECTS OF RADIATION ON THREE SILICONE DIELECTRIC FLUIDS. B. E. Curtsinger (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). July 31, 1963. Contract AF33(657)-7201. 71p.

Three silicone dielectric fluids — Dow Corning QF 1-

0158, General Electric SF 85(20), and General Electric SF 97(20)—were irradiated while their electrical properties were being measured. There were samples of each fluid at temperatures of 40°F, 200°F, and 400°F. A mixed neutron-gamma radiation field was provided by the Ground Test Reactor. The samples were subjected to a maximum gamma dose of 2.5×10^{10} ergs/gm(C) and a maximum integrated neutron flux of 1.7×10^{15} n/cm^2 (E > 2.9 Mev). Extensive preirradiation measurements were made of the dielectric constant, dissipation factor, resistivity, and dielectric strength of each fluid. These measurements were used as a standard to which the irradiation and the postirradiation measurements were compared. (auth)

657 (NARF-63-8T) MEASUREMENT OF RADIATION HEATING IN AEROSPACE STRUCTURAL MATERIALS. B. E. Morris, N. D. King, and H. G. Carter (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Sept. 1963. Contract AF33(657)-7201. 69p. (AD-421046; FZK-9-187)

Radiation heating measurements were obtained for several aerospace structural materials. The Aerospace Systems Test Reactor, positioned in the Outside ASTR Tank, was the source of radiation. Heating measurements were obtained throughout the following five configurations: 4 in. of T-61 weldable aluminum, 4 in. of Inconel-X, 4 in. of 6% borated polyethylene, 4 in. of 6% borated polyethylene preceded by 1 in. of lead, and 4 in. of 6% borated polyethylene preceded by $\frac{1}{4}$ inch of boral preceded by 1 inch of lead. Gamma and neutron dosimetry measurements were taken by means of a 4-cc ion chamber, gamma chemical dosimeters, sulfur pellets, and gold foils. Heating rates were calculated and both measured and calculated data are presented in graphic and tabular form. A method of correcting for heat leakage in the borated polyethylene transducer is outlined, and the required empirical parameters, obtained from a bake-oven experiment, are given. (auth)

658 (REIC-32) SPACE-RADIATION DAMAGE TO ELECTRONIC COMPONENTS AND MATERIALS. W. E. Chapin, D. J. Hamman, E. N. Wyler, and D. Jones (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Oct. 30, 1963. Contract AF33(657)-10085. 69p.

The results of experiments on the effects of space radiation on electronic devices and device materials normally used in circuits and systems are compiled. Electron, proton, and bremsstrahlung effects on the electrical and physical properties of semiconductor devices and materials are emphasized. Some results on other commonly used components are included, and metals are also discussed. Shielding against electrons and protons is considered. (41 references). (D.C.W.)

659 (UCRL-13092) CALIBRATION OF PRESSURE TRANSDUCERS FOR PLUTO RADIATION ENVIRONMENTS. Final Report. J. R. Burnett, Z. P. Azary, and R. S. Froelich (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Aug. 1963. For Univ. of Calif., Lawrence Radiation Lab., Livermore. Contracts W-7405-eng-48 and SANL 730/3186005. 99p.

The performances of selected pressure transducers in neutron and gamma radiation environments characteristic of Tory II-C applications were investigated. The effects which were evaluated included: permanent damage to materials; temporary degradation or damage due to radiation heating; ionization-induced false signals and noise; and radioactivation of materials. Emphasis was placed on calibration of transducer error due to radiation heating and induced false signals and noise. The test results indicate the suitable extreme environment transducer and heat sink designs for use on Tory II-C applications. Calibration data on transducer performance in radiation environments equivalent to the Tory II-C radiation environments are also presented. (auth)

660 (USAELRDL-TR-2320) THE EFFECTS OF PULSE NUCLEAR RADIATION ON QUARTZ CRYSTAL UNITS. Joseph M. Stanley (Army Electronics Research and Development Lab., Fort Monmouth, N. J.). Nov. 1962. 24p. (AD-298552)

A series of experiments to study the performance of quartz crystal units in pulse nuclear environments is described. The magnitude of observed transient effects is shown to be related to the type of radiation, dose, and, to a certain extent, the electrode material. Data are also presented to indicate that reactor-generated pulse nuclear radiation does not induce permanent effects in either precision or nonprecision military crystal units. The results of the exposure of moderate precision crystal units in an environment created by a nuclear weapon are reviewed and compared with tests made at pulse reactors and accelerators. Permanent frequency changes observed in this test are shown to be in excess of specification requirements. (auth)

661 NEW GREASES WITHSTAND HIGH RADIATION DOSES. Sharda DasGupta and J. T. Slobodian (Atomic Energy of Canada Ltd., Ottawa). Can. Nucl. Technol., 2: 42-4(1963).

New radiation-resistant greases were prepared from commercially available greases by carrying out radioinduced reactions with styrene. The radiation tolerances of the products are 250 and 1000 times higher than the starting materials and any similar product available. Properties of the new styrene greases before and after exposure to large radiation doses are in no case inferior to the original greases and in some respects the characteristics are improved. The method for the preparation of the greases is reported and test properties of original and irradiated greases are tabulated. (P.C.H.)

662 PROPERTIES OF IRRADIATED AND PERIODICALLY ANNEALED GRAPHITE. S. Aronson, D. G. Schweitzer, and R. M. Singer (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 17: 192-3(Oct. 1963). (BNL-6882)

Samples of AGOT nuclear grade graphite were irradiated with neutrons at 30-40°C for 200-240 Mwd/at. of uranium. The samples were temporarily removed from the reactor at regular intervals and annealed at 350°C for 1-4 hrs. They were also annealed after the final irradiation. Dimensional, C-axis, electric conductivity, Hall coefficient, thermal conductivity, and stored energy data were obtained using standard techniques on samples cut perpendicular to the extrusion axis of the graphite bar. (C.E.S.)

663 EFFECT OF RADIOACTIVE RADIATIONS ON THE MAGNETIC PROPERTIES OF FERRITES. M. A. Nizametdinova and E. M. Lobanov (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii, Akad. Nauk Uz. SSR, 1: 267-70(1961).

Variations in the properties of ferrites under neutrons, protons, and gamma irradiation were studied. Variations in magnetic and electrical properties attributable to variations in the crystal lattice depend on the nature and dose of the radiation as well as on the composition of the ferrite. For this reason several types of ferrites of various shapes were investigated. Measurements showed that total losses

increase more rapidly with increasing field strength after, rather than before, irradiation. The hysteresis loop became more rectangular when the ferrite was irradiated. Coercive force generally remained unchanged. Variations in the properties of ferrites under irradiation are either attributed to displacement of the ions in the lattice, or to variation in spin exchange interaction, in the valency of the ions of the interstitial metals, in ion spin orientation, and in domain movement. (TCO)

664 VARIATION IN THE ELECTRIC PROPERTIES OF POLYCRYSTALLINE BORON UNDER GAMMA RADIATION. M. M. Usmanova (Physicotechnical Inst., Academy of Sciences, Uzbek SSR). Tr. Tashkentsk. Konf. po Mirnomu Ispol'z. At. Energii Akad. Nauk Uz. SSR, 1: 281-3(1961).

A procedure for sintering boron samples and measuring their conductivity is reported. Pure (94%) amorphous boron powder was filled into a special mold, moistened with distilled water, compacted at 50 atm, and then sintered in vacuo at a maximum temperature of 1200°C. The samples were placed in a quartz tube. Best results were obtained by repeated sintering with the furnace temperature slowly rising to 1200°C in the course of 8 hr, held for 30 to 90 min, and then cooled to room temperature. This was repeated up to five times for each sample. The sample was purified during sintering. Measurements were made with two tube megohmmeters and a high sensitivity galvanometer. Various contacts were applied to the surface by spraying, evaporating, and in a paste. The most stable contact was obtained by burning in a silver paste in vacuo at 600°C. Exposure to irradiation caused no change in properties. On irradiation with doses of $(50-150)\cdot10^6$ r, most of the samples showed an increase of 8–16% in electrical conductivity. This is due to the increase in carrier concentration (increasing number of free holes), or displacement of nuclei. (TCO)

665 VARIATION IN LINEAR DIMENSIONS OF MOLTEN QUARTZ DURING GAMMA IRRADIATION. S. V. Starodubtsev and S. Azizov (Physicotechnical Inst., Academy of Sciences, Uzbek SSR). Tr. Tashkentsk. Konf. po Mirnomu Ispol'z At. Energii, Akad. Nauk Uz. SSR, 1: 283(1961).

Molten quartz was exposed to Co^{60} gamma radiation and measurements were made on a microscope with about 10^{-4}% accuracy. The linear dimensions increased with dose, reaching a maximum at $9\cdot10^7$ r. At $18\cdot10^7$ r the dimensions decrease again, finally reaching their original values. Only a slight change occurs on increasing the dose up to $36\cdot10^7$ r. (TCO)

666 MECHANISM OF RADIATION DAMAGE TO GRAPHITE AT HIGH TEMPERATURES. D. R. de Halas and H. H. Yoshikawa (General Electric Co., Richland, Wash.). p.249-54 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

The radioinduced contraction of graphite, which is observed at high irradiation temperatures, is considered for a variety of types of graphitic material. Contraction is attributed to two separable processes. The first process is akin to low temperature irradiation damage and involves a slight expansion of the crystallites parallel to the c-axis and a corresponding contraction parallel to the a-axis. Because this type of damage is annealable, the amount of crystallite expansion and contraction is a function of the irradiation temperature and largely accounts for the temperature dependence in the radiation stability of graphite. The second process is non-annealable and seems to result from a graphitization-like phenomenon on poorly graphitized regions of artificial graphite. The poorly graphitized regions appear, for the greater part, to originate in crystallite boundaries and particle boundaries (binder) in the graphite. The degree of anisotropy of the graphite largely determines the interaction of the annealable and non-annealable dimensional changes and hence controls the observed overall behavior of graphite under high temperature irradiation. Furthermore, the use of low final processing temperatures or poorly graphitizing filler or binder increases the amount of non-annealable contraction and decreases the stability of the graphite. (auth)

667 THE EFFECT OF HIGH FLUX NEUTRON IRRADIATION ON THE PHYSICAL PROPERTIES OF GRAPHITE. W. N. Reynolds and J. H. W. Simmons (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.255-65 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Changes in the physical properties of graphite induced by high flux neutron irradiation were observed over a wide range of temperature under conditions that permitted close control of the temperature and neutron flux. The work consisted of a study of the changes in thermal conductivity, thermal expansion, Young's Modulus, electrical resistivity, and crystallographic parameters with neutron irradiation and the effect of subsequent annealing on the properties. The results are discussed in the light of electon microscope studies of defects produced in natural graphite crystals under similar irradiation conditions. At the lowest temperature in the range studied, 150°C, large changes in thermal conductivity were observed. No evidence was obtained for saturation at high doses of either thermal conductivity or lattice parameter changes, even at the highest temperature studied, 650°C, where the properties studied change at a much reduced rate. Complex changes in thermal expansion were observed, probably due to the combined effects of the lattice parameter distortion and changes in pore structure. (auth)

668 THE IRRADIATION INDUCED PLASTICITY OF GRAPHITE. H. H. W. Łosty (General Electric Co. Ltd., Wembley, Eng.), N. C. Fielder, I. P. Bell, and G. M. Jenkins. p.266-73 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Considerable evidence is presented for the occurrence of an irradiation induced creep in graphite. Specific creep constants deduced from experiments in shear and compression are in substantial agreement. The creep is linearly dependent on stress up to about 1500 psi. It is also shown that the low temperature irradiation growth of graphite can be restrained by the application of external stress. The creep constant calculated on the simplest assumption that this is a relaxation process agrees with that of the spring experiment. (auth)

669 MECHANICAL PROPERTIES OF IRRADIATED GRAPHITE; MODIFICATION OF THE HARDNESS BY IRRADIATION AND ANNEALING. J. Rappeneau and G. Jouquet (Centre d'Etudes Nucleaires, Saclay, France). p.274-83 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962. (In French)

Studies were made on determining the condition of graphite core samples by evolution of the graphite under the effects of radiation. A study on the hardness d_0 of non-irradiated graphite permitted the relation existing between the hardness and the apparent density to be established as well as the influence of anisotropy. Under the effects of radiation the hardening $\Delta h/h_0 = (h_1 - h_0)/h_0$ is expressed as a linear function of the dose to the temperature of the ir-

radiation given. The results were obtained for temperatures between 50 and 150°C and some doses going as far as 1.2×10^{20} neutrons cm^{-2}. The variation of the increase of hardening by dose increase was determined as a function of the irradiation temperature. The recovery of hardening by thermal annealing was also studied. The rate of recovery was found to depend on the annealing temperature, as well as on the amount of damage caused by irradiation. An increase in the rate of recovery by °C, as a function of the annealing temperature, reaches a maximum near 250°C. The samples studied determined approximately the hardness of non-irradiated graphite when the annealing temperature reaches 900°C. (P.C.H.)

670 STORED ENERGY AND DIMENSIONAL CHANGES IN REACTOR GRAPHITE. H. Bridge, B. T. Kelly, and B. S. Gray (United Kingdom Atomic Energy Authority, Warrington, Eng.). p.289-316 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Investigations of the effects of fast neutron irradiation on graphite were carried out for several years. Results obtained during the investigations are presented for the range of temperature 30–306°C and for irradiation doses up to 10^{21} nvt. The data to 30°C are extended by measurements of samples of highly irradiated graphite from Hanford to doses $\approx 3 \times 10^{21}$ nvt. Data on the stored energy associated with radioinduced lattice defects are presented, and the rate of increase of irradiation damage as measured by total stored energy content and the release of stored energy in unit temperature rise during tempering are discussed. Results were obtained on the effect on stored energy content of thermal annealing, re-irradiation after thermal annealing, and irradiation annealing. The results of the thermal and irradiation annealing experiments are described by a phenomenological modification of the Vand model of thermal annealing of disordered metal films. Data on the changes in crystal lattice parameters and the associated dimensional changes in the polycrystalline reactor graphite are also presented. The results are shown to be reasonable agreement with the theory of irradiation growth. Changes in mechanical properties accompanying the above effects are also described and discussed. (P.C.H.)

671 ENERGY STORAGE IN IRRADIATED GRAPHITE. ENERGY RELEASE AS A FUNCTION OF SUCCESSIVE ANNEALS. J. Rappeneau and M. Quetier (Centre d'Etudes Nucléaires, Saclay, France). p.317-27 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962. (In French)

The accumulation of energy by graphite was studied as a function of time, and some methods of measurement of the energy are described. Annealing at constant temperature gave a total value of H_{20}^{400} cal g^{-1} of the energy liberated by the irradiated graphite between ambient temperature and 400°C. Differential thermal analysis permitted the evolution to be obtained from the enthalpy $dH/d\theta$ (cal g^{-1} $°C^{-1}$) as a function of the temperature θ, the latter variant between atmospheric and 800°C. It is shown that the energy liberated by the irradiated graphite increases linearly as a function of the dose to the irradiation temperature before the first annealing. The effects of annealing were established by comparison of the energies, total H_{20}^{400} or some spectra of energy determined before and after annealing of the moderator. A rather weak residual energy continued in the graphite after annealing. Also, before the second and third anneals of the moderator of the G1 pile an early effect was observed; the energies accumulated very rapidly to the beginning of the re-irradiation of the annealed graphite, whatever the irradiation temperature. The early effect disappeared for the rather weak doses of irradiation ($\simeq 0.25 \times 10^{20}$ neutrons cm^{-2}), then the energy, to a given irradiation temperature, increased to a new linearity with the dose, the velocity of growth being near that observed before the first annealing. As a function of the successive annealings, the energy stored by the graphite underwent an evolution that manifested itself by a progressive modification of the energy spectra. (P.C.H.)

672 POST-IRRADIATION MEASUREMENTS OF THERMAL CONDUCTIVITY BETWEEN 200 AND 600°C FOR LOW PERMEABILITY GRAPHITES. Robert A. Meyer (General Atomic Div., General Dynamics Corp., San Diego, Calif.) and Donald G. Schweitzer. p.328-34 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

Thermal conductivity values of low permeability graphites at 200–600°C were determined by using 3 chromel-constantan thermocouples embedded in electrically heated samples. The energy input is the product of the current passing through the sample and the potential drop between the end and the center thermocouples. Samples $\frac{1}{2}$ in. OD × $1\frac{1}{2}$ in. long were inserted in three different reactors at irradiation temperatures between 50 and 500°C. The fast neutron exposures were usually in excess of 10^{20} nvt. The change in conductivity, which is expressed as $(K_0/K - 1)$, is from 0.5 to 0.3 at 200°C and 0.1 to 1.0 at 600°C where K_0 and K are the pre- and post-irradiation values respectively. K values were found to be insensitive to the measuring temperatures provided these did not greatly exceed the irradiation temperatures. Annealing effects were observed when the measuring temperature was 200–400°C above irradiation values. The effects of graphite composition and heat treatments to K are noted and discussed. (P.C.H.)

673 MICROSAMPLING OF IRRADIATED MATERIALS. C. L. Boyd (General Electric Co. Richland, Wash.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 223-31(1963). (HW-SA-2983-(DRAFT; CONF-187-9)

Equipment and techniques developed for remote microsampling of irradiated ceramic materials by microdrilling are being used in the study of fission product migration phenomena. Design of the equipment includes provisions for read-out of sampling locations, remote changing of drills, remote collection of microsamples, magnified visual control of the drilling operation, and micrometer control of drill in-feed. Samples obtained by this technique are analyzed by radiochemical or spectrographic methods to study the effect of in-reactor exposure on fission product migration and segregation of mixtures or alloys. Data obtained through analysis of microsamples provided valuable fuel element design information concerning fission product migration in ceramic fuel element materials irradiated at core sintering temperatures. (auth)

674 POST-IRRADIATION METALLOGRAPHIC LABORATORY AT GE-NMPO. E. W. Filer and S. A. Leighton (General Electric Co., Cincinnati). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 295-310(1963).

The construction of the cell and equipment used in preparing irradiated materials for metallographic evaluation are discussed. The mounting, grinding, polishing, etching, and photomicrographic procedures used in preparing the various metallic and ceramic materials are given along with representative results. The various pitfalls to be avoided are stressed. The methods used and the results

obtained in replicating materials remotely for electron microscopic studies are discussed. (auth)

675 THE FRACTURE BY ELECTRICAL DISCHARGE OF GAMMA IRRADIATED SHIELDED WINDOW GLASS. F. C. Hardtke and K. R. Ferguson (Argonne National Lab., Ill.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 369-81(1963).

Four-inch cubes of commercial shielding window glasses were tested for susceptibility to fracture by electrical discharge following intense gamma irradiation. All glasses tested were easily discharged by an impact probe after an exposure of 1 to 10 megaroentgens. The negative charge collected by the probe circuit increased with exposure rate and decreased with the irradiation temperature. This collected charge is thought to be an approximate measure of the internal charge acquired by the glass cube. A serious effect for shielding windows, is that a small dendritic fracture, once formed, will continue to grow with subsequent exposure. Recommendations are made concerning the design of windows to reduce their susceptibility to fracture. (auth)

676 GAMMA-RADIATION-INDUCED CONDUCTIVITY IN NUCLEAR SHIELDING GLASSES AS DETERMINED BY SPACE CHARGE DECAY. F. M. Ernsberger and T. E. McGary (Pittsburgh Plate Glass Co., Harmar Township, Penna.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 383-93(1963).

Nuclear shielding glasses are shown to acquire a significant degree of transient electrical conductivity during gamma irradiation. An approximate measurement of the effect was made by observing the gamma-induced decay of a space charge placed in the glass by means of an electron accelerator. The previously-formulated polarization theory of gamma-induced electrical breakdown is believed to require modification to take this effect into consideration. It is proposed that the electrical strain induced by gamma irradiation is chiefly a result of negative space charge rather than a result of dipole accumulation, and that a practical method for eliminating the electrical discharge breakdown effect is the provision of sufficient ionic conductivity in the glass. (auth)

677 ELECTRICAL DISCHARGE IN GAMMA IRRADIATED LEAD SHIELDING GLASS. Francis X. Rizzo, Albert C. Muller, and Martin S. Zucker (Brookhaven National Lab., Upton, N. Y.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 395-412(1963).

A mathematical model, describing discharge of shielding glass as a result of gamma irradiation was formulated and experimentally verified to be a good order-of-magnitude approximation. Experimental results indicated an electronic process, associated with storage of electrons in color centers similar to those of cerium, is involved. Studies indicated further that lead in glass may serve to decrease dielectric breakdown strength. Sodium ion has beneficial effect in that it may serve to decrease buildup of net charge and inhibit coloration of glass. (auth)

PHYSICS

General

678 (AD-297949) HIGH-PERVEANCE GUN STUDY. Quarterly Report No. 6, September 1–December 1, 1962. R. D. Harris and J. R. Hechtel (Litton Electron Tube Corp., San Carlos, Calif.). Dec. 29, 1962. Contract DA-36-039-SC-87313. 37p.

Fabrication techniques for the electrostatic gun are discussed. Several problems are resolved. This is proven by preliminary test data which agree quite closely with theoretical beam calculations. Progress is reported on the magnetron injection guns. First qualitative results are reported in a test of a conventional magnetron injection gun in klystron. Further data is presented comparing the inverted and conventional guns. The completion of the first inverted gun is reported. Further computer results are reported. This includes a new scheme for improving the accuracy of the trajectory plots. (auth)

679 (ARL-63-175(Pt.I)) A CRITICAL SURVEY OF MAGNETOFLUID DYNAMICS. PART I. GENERAL DISCUSSION. Shih I. Pai (Maryland. Univ., College Park). Oct. 1963. Contract AF33(657)-7805. 83p.

A critical survey of magneto-fluid dynamics (MFD) is given with special emphasis on the fundamental features of this branch of fluid dynamics and the new phenomena that differ from those of ordinary fluid dynamics. After some discussions of the fundamental equations of magneto-fluid dynamics and their properties, several typical flow problems of magneto-fluid dynamics are analyzed including one-dimensional flow, MFD power generation, and inviscid and viscous flows. Finally the need for good experimental investigations is pointed out, and improvements and extensions of classical magneto-fluid dynamics are briefly discussed. (85 references). (auth)

680 (D2-9878-3(Sect.H)) ELECTRON PRODUCTION AND TRANSPORT IN ELECTRONIC MATERIALS IN A PULSED NUCLEAR ENVIRONMENT. H. B. Almond and V. H. Schmidt (Boeing Co., Seattle). 70p.

The chief source of high-energy electrons from a fission spectrum is the Compton effect. The density of Compton recoil electrons from a plate of thickness large compared to electron range but small compared to gamma range increases slowly with atomic number. Expressions based on the Kukla gamma spectrum are derived for net current flow to or from a plate, and net rate of creation of space charge within the plate, as a function of the thickness and composition of that plate and others between it and the gamma source. An expression is also derived to take into account the backscatter and secondary electron production between plates of the same and dissimilar materials. The results of the data obtained on bare plates and shielded plates tested at Kukla are presented. A quick analysis of the data indicates that the bare plate data do not correlate too well with the calculated values. This may be caused by a large unexpected electron scatter anisotropy in the test area and by backscattering effects which were not included. The shielded plate data were taken in an attempt to shield out the room scatter electrons and introduce a known scattering source. The items tested included not only metals but also graphite and polyethylene. These two materials appear to be susceptible to the neutron component of the radiation as well as the gamma component, since both of these materials produce stronger signals than were expected. (auth)

681 (D2-9878-3(Sect.I)) CREATION OF ION PAIRS IN MATERIALS IN PULSED RADIATION ENVIRONMENTS. H. D. Glenn and V. H. Schmidt (Boeing Co., Seattle). 65p.

Starting with a Kramers theoretical 300-kv flash x-ray spectrum, the generation rate, g, of ion pairs in elements lithium through lead (excluding gases) is evaluated. Also g for the gamma and the neutron spectra of Kukla are calculated separately enabling a comparison of contribution to g of each. The sensitivity of g to spectral variations is checked on flash x ray by computing g for a heavily filtered NBS x-ray spectrum in addition to comparison that can be made with Kukla results. Finally, the effect of depth on g is estimated for 300 kv flash x-ray spectrum. (auth)

682 (LADC-5635) ON E_{01} WAVE WINDOWS. Bernard Hayes (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 10p.

Relations for determining the system parameters for which E waves in waveguides can propagate without reflection from one dielectric medium to another are derived and illustrated. (D.C.W.)

683 (DASA-1266-2) FEASIBILITY STUDY OF AN EXPERIMENTAL APPARATUS FOR UNIDIMENSIONAL STRESS PROPAGATION IN SOIL. Final Report, Part II. H. W. Kriebel (Stanford Research Inst., Menlo Park, Calif.). Feb. 21, 1962. Contract DA-49-146-XZ-018. 43p. (AD-297771)

For the design of underground structures to withstand nuclear explosions, the dynamic properties of various soils and rocks under dynamic loading must be understood. Mathematical models for unidimensional soil motion must be verified experimentally before more complicated problems can be tackled theoretically. A test apparatus was designed and built to produce a one-dimensional stress wave in a soil column and measure acceleration and stress caused by the propagation of the stress wave. The dynamic load generator which generates the stress wave was designed and built by Boynton Associates. A series of experiments conducted with the apparatus indicates that the radial distribution of particle velocity is fairly uniform at the top of the soil column, and becomes more uniform with soil depth. The data demonstrate the attenuation of the stress wave, but the instrumentation must be improved before attenuation can be measured accurately. Most of the apparatus functioned satisfactorily, but before further experimental investigation, changes should be made to improve the smoothness of the inside of the confining tube, to eliminate noise from the records, and to improve time resolution of the records. (auth)

684 (EURAEC-420) EXPERIMENTAL METHODS AND EQUIPMENT FOR DIFFUSION MEASUREMENTS OF RADIOACTIVE RARE GASES IN SOLIDS (RARE-GAS DIFFUSION IN SOLIDS 7). F. Felix and P. Schmeling (Hahn-Meitner-Institut für Kernforschung, Berlin). 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 064-61-8-RDD. 41p. (EUR-111.e)

A review is given on methods and equipment used for the measurement of release of radioactive rare gases in solids, with a discussion of advantages or disadvantages. Continuous methods with sweepgas or circulation and various discontinuous methods are discussed and apparatus

used for Hahn emanation-, DAD- or PAD-experiments are described. Sampling purification and measurement of radioactive rare gases as well as materials to be used for measuring rare gas diffusion at high temperatures in oxygen sensible systems are also included. 153 references are given. (P.C.H.)

685 (MDL-Q1) [ELECTRON BEAM, SOLID STATE, AND PLASMA STUDIES]. Quarterly Report, April 1–June 30, 1962. (Utah. Univ., Salt Lake City. Microwave Devices Lab.). 45p. (AD-288237)

Electron beam, plasma, and solid state research directed toward the extension of the useful frequency spectrum into the millimeter and submillimeter regions and on the improvement of existing devices and techniques in the microwave spectrum is summarized. (D.C.W.)

686 (NP-13246) DESIGN, FABRICATION, AND TESTING OF A CESIUM ION ROCKET ENGINE. Third Quarterly Progress Report, March 1–May 31, 1963. (Hughes Aircraft Co. Hughes Research Labs., Malibu, Calif.). Contract NAS5-517. 139p.

The Model 3C ion engine was subjected to environmental tests and was demonstrated to be capable of withstanding the SERT-I flight launch environment. Integration tests of the engine with power conditioning equipment showed sufficient reliability to achieve the objectives of the SERT-I space test. A number of multiple linear strip engines were built and tested. The performance of these engines, in maximum current density and time of stable operation, was limited by excessively high drain currents which frequently resulted in engine failure. Several potential causes of the high drain currents were investigated. A breadboard system of the strip engine feed system was assembled and preliminary performance measured. Separate testing of the valve and capillary flow control was accomplished. Power conditioning equipment having increased inverter and accel current capabilities and soft turn-on characteristics became available. This resulted in much better integration performance. A 254 hr test was made to study oxygen transport through a simulated feed system. The effect of oxygen on vapor pressure and other qualitative determinations were made. Means were established to separate fine spherical tungsten powder in sufficiently narrow ranges of distribution to warrant forming compacts for evaluation as ionizers. (N.W.R.)

687 (NP-13274) PROGRESS REPORT ON [COORDINATED SCIENCE LABORATORY ACTIVITIES], JUNE–AUGUST 1963. (Illinois. Univ., Urbana. Coordinated Science Lab.). Sept. 25, 1963. Contract DA-36-039-AMC-02208(E). 62p.

Research progress on the electric vacuum gyroscope, computers, system theory, computer teaching logic, vacuum instrumentation, vacuum electrical breakdown, and evaporated thin films is reported. Separate abstracts were prepared for sections on plasma physics, surface and atomic physics, and high magnetic field superconductors. (D.C.W.)

For abstracts of individual sections see: 744, 954, and 1129.

688 (PAN-269) ZEEMAN SPLITTING OF THE 14.4 kev GAMMA LINE OF ^{57}Fe IN $CoFe_2O_4$ INVESTIGATED BY THE MÖSSBAUER EFFECT. I. Dezsi, A. Z. Hrynkiewicz, and D. S. Kulgawczuk (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). May 1963. 3p.

Zeeman splitting of the 14.4-kev gamma line of Fe^{57} in cobalt spinel ($CoFe_2O_4$) was studied. Two values of the magnetic field intensity at iron nuclei $H_1 = (509 \pm 5)$ kØersted and $H_2 = (528 \pm 5)$ kØersted are found. (auth)

689 (RADC-TDR-62-524) FUTURE ASTRO-COMMUNICATION TECHNIQUES. Final Report. J. M. Brumbaugh, J. Vollmer, and L. W. Zelby (Radio Corp. of America, Camden, N. J.). Oct. 1962. Contract AF30(602)-2151. 46p. (AD-292966)

Work performed during a study of future astro-communications techniques included a theoretical analysis of Cherenkov power generation for various beam geometries, rigorous derivation of nonresonant regeneration conditions in a circular cylindrical reaction structure, analysis of efficiency with and without the utilization of a potential well, and a general analysis of the Cherenkov effect and its relation to the Roentgen current. The experiment arrangement and techniques are described, and measurements of observed Cherenkov radiation and velocity dispersion are reported. (auth)

690 (RM-3538-PR) INVARIANT IMBEDDING AND THE INTEGRATION OF HAMILTON'S EQUATIONS. Richard Bellman and Robert Kalaba (RAND Corp., Santa Monica, Calif.). Feb. 1963. Contract AF49(638)-700. 18p. (AD-297954)

Based on earlier work on the application of the principle of invariant imbedding to problems in transport theory, a countercurrent flow model that can be associated with any mechanical process described by Hamilton's equations of motion is described. The determination of certain reflection and transmission functions, which occur naturally in the transport process, is shown to lead to the solution of Hamilton's equations. Some examples are given, and some possible future applications are sketched. (auth)

691 (TID-3911(Rev.1)) THERMOLUMINESCENCE. Bibliography. Ernest E. Angino (Texas. Agricultural and Mechanical Coll., College Station); and N. Grogler (Bern. Universität. Physikalisches Institut). Oct. 31, 1963. Contract AT(40-1)-2061. 48p.

References (580) are given to reports and U. S. and foreign journals and books published from 1675 through 1962. (P.C.H.)

692 (TID-18275) REPORT ON VISITS TO SOME EUROPEAN LABORATORIES, [AUGUST 12, 1962–SEPTEMBER 10, 1962]. Bernard B. Kinsey (Texas. Univ., Austin). Contract AT(40-1)-7972. 11p.

The purpose of this trip was to obtain general information on the layout of laboratories equipped similarly to that of the new nuclear physics laboratory of The University of Texas, now under construction, and to discuss with experts in this field the instrumentation necessary for research. Given are first some brief remarks about the equipment and buildings to be set up at The University of Texas; second, some general remarks on the design of buildings for tandem accelerators; third, comments on fittings; and fourth, specific equipment which are needed at The University of Texas and on which decisions are now required. The latter concern a heavy-particle spectrometer and a β-ray spectrometer for the measurement of internal conversion electrons. (auth)

693 (TID-19532) THE STUDY OF VERY THIN FILMS BY ELLIPTICALLY POLARIZED LIGHT. R. C. Plumb and F. P. Mertens (Worcester Polytechnic Inst., Mass.). [Sept. 27, 1963]. Contract AT(30-1)-2479. 10p.

The use of elliptically polarized light to study very thin films on metal surfaces involves several pitfalls and possible sources of error. These difficulties include absorb-

ing layers at the metal-dielectric interface, calibration using barium stearate monolayers, anomalously high refraction indices in the Drude equations, and complex null adjustments. (D.L.C.)

694 THE METHOD OF IMAGES IN GEOMETROSTATICS. Charles W. Misner (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 24: 102-17(Oct. 1963).

Since there exist no nonflat singularity free static solutions of the empty-space Einstein equations the name geometrostatics is given to the study of the time-symmetric (instantaneously static) initial value problem. Using the method of spherical inversion images from electrostatics, the initial values for a time-symmetric solution of the empty space Einstein equations having the topology of an arbitrary number of Einstein–Rosen bridges are constructed. The initial data are analytic and asymptotically flat with positive apparent mass. (auth)

695 REFORMULATION OF GENERAL RELATIVITY IN ACCORDANCE WITH MACH'S PRINCIPLE. Feza Guersey (Middle East Technical Univ., Ankara). Ann. Phys. (N. Y.), 24: 211-42(Oct. 1963).

It is argued that Einstein's Theory of General Relativity as it stands incorporates Mach's Principle. The boundary conditions for Machian solutions are stated in a coordinate system in which the cosmological background is described by a conformally flat metric. The metric tensor $g_{\mu\nu}$ is then written as a product of the scalar density φ^2 and a tensor density $\gamma_{\mu\nu}$ with unit determinant. In the coordinate system that was so chosen φ describes the cosmological structure, while $\gamma_{\mu\nu}$ refers to gravitational phenomena. This becomes clear when Einstein's fundamental equations are rewritten in terms of φ and $\gamma_{\mu\nu}$. Then $\kappa\varphi^{-1}$ is seen to play the role of the gravitational constant instead of κ in the weak field approximation. The quantity $\kappa\varphi^{-1}$ can be expressed in terms of the radius and the total mass of the universe and the sign of the forces between inhomogeneities of the metric is determined by the requirements of Mach's principle. The forces that derive from φ are found to be repulsive for the cosmological background, leading to the expansion of the universe, while attractive gravitational forces arise from the deviations of $\gamma_{\mu\nu}$ from the Minkowski metric. Various statements associated with Mach's Principle are discussed in the light of this reformulation of Einstein's Theory. (auth)

696 THE FOUNDATIONS OF NONEQUILIBRIUM STATISTICAL MECHANICS. [PART] I. Guido Sandri (Aeronautical Research Associates, Princeton, N. J.). Ann. Phys. (N. Y.), 24: 332-79(Oct. 1963).

A novel philosophy of irreversible dynamics is formulated. This philosophy stems from the claim that the kinetic equations available are essentially exact and cannot be improved. That is, for kinetic gases (those whose behavior is characterized by that of one typical particle) these equations constitute closed, statistically complete knowledge. This thesis is demonstrated by using a technique that separates completely the different time components exhibited by the evolution of a gas when an appropriate parameter (characteristic of the regime in which the gas is found) is small. The expansion in this parameter is pushed up to its breaking point marked by the presence of an intrinsic divergence. With this technique one can pinch off the series at this point and remain with a closed, finite system of equations. The argument is made compelling by the fact that the same divergence occurs for all gaseous regimes (short-range, weak-coupling, dilute weak-coupling and Debye). It is proved that not all isolated gases will eventually become kinetic. In fact, the necessary and sufficient conditions that the initial departure from equilibrium must satisfy for kineticity to eventually set in are deduced directly from the Liouville equation. When statistical information about a gas is needed beyond that afforded by the knowledge of the motion of the average particle a new asymptotic expansion of the Liouville equation must be deviced. Thus, for example, the preponderance of three-body collisions demands knowledge of the evolution of the average pair of particles. For this situation a pair-kinetic expansion is introduced. A hierarchy of increasingly more informative descriptions of a gas is thus envisaged. As a byproduct of this analysis, the limits of validity of Bogoliubov's assumption of synchronization and of his boundary condition are found, and the equivalence of Kirkwood's time averaging procedure (made systematic) with Bogoliubov's technique is proved. (auth)

697 THE FOUNDATIONS OF NONEQUILIBRIUM STATISTICAL MECHANICS. [PART] II. Guido Sandri (Aeronautical Research Associates, Princeton, N. J.). Ann. Phys. (N. Y.), 24: 380-418(Oct. 1963).

The discussion of the kinetic expansions of the Liouville equation is continued. The superkinetic expansions are introduced and discussed. (auth)

698 HYDRODYNAMIC EQUATIONS AND CORRELATION FUNCTIONS. Leo P. Kadanoff (Univ. of Illinois, Urbana) and Paul C. Martin. Ann. Phys. (N. Y.), 24: 419-69(Oct. 1963).

The response of a system to an external disturbance can always be expressed in terms of time dependent correlation functions of the undisturbed system. More particularly the linear response of a system disturbed slightly from equilibrium is characterized by the expectation value in the equilibrium ensemble, of a product of two space- and time-dependent operators. When a disturbance leads to a very slow variation in space and time of all physical quantities, the response may alternatively be described by the linearized hydrodynamic equations. The complicated structure the correlation functions must have in order that these descriptions coincide are presented. From the hydrodynamic equations the slowly varying part of the expectation values of correlations of densities of conserved quantities is inferred. Two illustrative examples are considered: spin diffusion and transport in an ordinary one-component fluid. Since the descriptions are equivalent, all transport processes that occur in the nonequilibrium system must be exhibited in the equilibrium correlation functions. Thus, when the hydrodynamic equations predict the existence of a diffusion process, the correlation functions will include a part that satisfies a diffusion equation. Similarly when sound waves occur in the nonequilibrium system, they will also be contained in the correlation functions. The description in terms of correlation functions leads naturally to expressions for the transport coefficients like those discussed by Kubo. The analysis also leads to a number of sum rules relating the dissipative linear coefficients to thermodynamic derivatives. It elucidates the peculiarly singular limiting behavior these correlations must have. (auth)

699 DIFFERENTIAL ENERGY LOSS MEASUREMENTS FOR α-RAYS IN METAL FOILS. S. Barkan (Istanbul Univ.). Istanbul Univ. Fen Fak. Mecmuasi, Seri C, 28: 71-80(Jan.-Apr. 1963).

Aluminum, gold, and nickel were used as absorbers, having thicknesses to cause roughly 10% energy loss. A silicon solid-state counter was used as detector. The sources were Pu^{239}, Po^{210}, Cm^{244}, Bi^{212}, Cm^{242}, Po^{214}, and Po^{212}. A graph showing dE/dx in kev as a function of en-

ergy in Mev for the above sources that cover the unmeasured energy range of 5 to 9 Mev for α particles is given. The experimental values of energy loss determined for the above substances agree, within experimental error, with the interpolated curve given by Allison et al., for protons of the corresponding energy range. (auth)

700 EFFECTIVE DEPTH OF FORMATION OF X-RAY LINE RADIATION. Sema'an I. Salem (Long Beach State Coll., Calif.) and John C. Watts. J. Chem. Phys., 39: 2259-62(Nov. 1, 1963).

The mechanism of production of line radiation in a thick target differs from that of bremsstrahlung radiation. As a result the effective depths of formation of the two types of radiation, under identical conditions, are not the same. With relatively low voltage across the x-ray tube, the average change in the depth of production with voltage was found to be 300 A/kv for the continuum while the line data gave a value of 440 A/kv, in anode material having an atomic number of about 30. The dependence of the two quantities on the takeoff angle was also investigated. (auth)

701 COMPARISON OF TWO GENERALIZATIONS OF MAXWELL'S EQUATIONS INVOLVING CREATION OF CHARGE. Ll. G. Chambers (University Coll. of North Wales, Bangor, Wales). J. Math. Phys. (N. Y.), 4: 1373-5 (Nov. 1963).

A comparison is made of the Lyttleton–Bondi and the Watson theories for the electromagnetic fields produced when charge is created. It is shown that, except when dimensions of the order of the radius of the Universe are involved, the difference is negligible and that consequently the Watson theory, being mathematically more simple, is the better. (auth)

702 REMARKS ON GRAVITATIONAL EXPERIMENTS. J. Weber (Inst. for Advanced Study, Princeton, N. J.). Nuovo Cimento (10), 29: 930-4(Aug. 16, 1963).

The essentially new features of the methods proposed earlier for measurement of the Riemann tensor and search for gravitational radiation are emphasized. Reply is made to the criticism of Gertsenshtein, Pustovoit, and Ginzburg. (auth)

703 KNIGHT SHIFTS AND LINEWIDTHS OF THE Pb^{207} NUCLEAR MAGNETIC RESONANCE IN LEAD–INDIUM ALLOYS. Rex J. Snodgrass and Lawrence H. Bennett (National Bureau of Standards, Washington, D. C. and Univ. of Maryland, College Park). Phys. Rev., 132: 1465-74(Nov. 15, 1963).

The nuclear magnetic resonance of Pb^{207} was observed and accurately measured at room temperature and 77°K in pure lead metal powder and in a series of lead–indium alloy powders containing up to 75% indium. Upon the addition of indium, the central frequency of the Pb^{207} absorption line increases by a small fraction of the linewidth. At 5 Mc, this frequency shift between pure lead and 20 at. % In is 800, compared to a linewidth of 14 kc in the 20 at. % In sample. The increase in frequency is also a small fraction of the Knight shift, $\Delta k/k = 1.1\%$ up to 20 at. % In. In the cubic lead phase, the frequency shift is linear with composition. Volume effects, which may be of sufficient magnitude to cause appreciable frequency shifts, preclude the possibility of a definite conclusion regarding charge oscillations of the type discussed by Friedel and others. From the temperature dependence of the linewidth, the spin-lattice relaxation time is found to be $T_1 = 3.6 \times 10^{-4}$ sec at 77°K. The linear field dependence of the linewidth in the alloys is primarily attributed to anisotropic Knight-shift broadening, although isotropic Knight-shift broadening is not excluded. Upon alloying, the low-field absorption linewidth increases rapidly due to a combination of indirect spin exchange and pseudodipolar coupling, and the line shape changes from Lorentzian toward Gaussian. A second moment analysis yields a value for the near-neighbor exchange constant $h^{-1}|A_{Pb-In}| = 0.9$ kc. The pseudodipolar exchange constant is found to be $h^{-1}|B_{Pb-In}| = 1.0$ kc. Large values for the ratio B_{Pb-In}/A_{Pb-In} and the ratio of pseudodipolar to classical dipolar indicate that the amount of p character probably greatly exceeds the amount of s character in the electron wave functions at the Fermi surface in this alloy and is consistent with the observation of anisotropic Knight-shift broadening. (auth)

704 X-RAY INTERFERENCE STRUCTURE IN THE SPECULARLY REFLECTED RADIATION FROM THIN FILMS. J. Sauro, I. Fankuchen, and N. Wainfan (Polytechnic Inst. of Brooklyn). Phys. Rev., 132: 1544-6(Nov. 15, 1963).

The phenomenon of x-ray interference upon reflection from thin films is well known. Superposed on this interference a second interference phenomenon was found which manifests itself as structure in the scattered radiation accompanying the specularly reflected x-ray beam. This new phenomenon is attributed to an interference between the components of scattered radiation originating at the two surfaces of the film. This interference structure in the scattered radiation was analyzed and used to determine the thickness of vacuum deposited copper films ranging in thickness from 250 to 1000 Å. The results were consistent with those obtained by previously described techniques. (auth)

705 ORIENTATION DEPENDENCE OF K-ABSORPTION EXTENDED FINE STRUCTURE OF A SINGLE CRYSTAL OF GERMANIUM. E. Alexander, B. S. Fraenkel, J. Perel, and K. Rabinovitch (Hebrew Univ., Jerusalem). Phys. Rev., 132: 1554-9(Nov. 15, 1963).

The fine structure of the K-absorption spectrum of a Ge single crystal was investigated with 90% polarized radiation. A single-crystal spectrometer and a fine focus x-ray tube were used. Absorption curves were obtained up to 300 ev from the main edge for five different positions of the absorber. No shifts of the extrema of the fine structure were observed. This experimental result is in agreement with theoretical considerations given here which show that absorption is independent of orientation for cubic symmetry and also for other cases of symmetry. (auth)

706 PHOTOELECTRIC EMISSION PHENOMENA IN LiF AND KCl IN THE EXTREME ULTRAVIOLET. R. G. Newburgh (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 132: 1570-5(Nov. 15, 1963).

The photoelectric emission from films of LiF and KCl and sheet Ni due to extreme ultraviolet radiation of 8 photon energies from 10 to 50 ev was studied with a planar-potential retarding analyzer. Current-voltage diagrams which provide an analysis of the normal energy of the emitted electrons were obtained. Photons of energies greater than twice the depth of the filled band below vacuum potential produce an effect which may be interpreted as two-electron emission. The results suggest this is an Auger process rather than being due to strong electron scattering. The results also indicate that the emission from LiF and KCl is preferentially in the forward direction. (auth)

707 FREE-POSITRON ANNIHILATION MEAN LIFE IN DIATOMIC AND RARE GASES IN LIQUID AND SOLID

STATES. D. C. Liu and W. K. Roberts (Lewis Research Center, Cleveland). Phys. Rev., 132: 1633-5(Nov. 15, 1963).

Measurements were made on the free-positron annihilation mean life, τ_1, in H_2, D_2, He, N_2, O_2, Ne, Ar, and Xe in liquid and/or solid states. To a fair approximation, the observed mean lives may be represented by the equation: τ_1 (nsec) = $0.31 + 0.15 \times 10^{-4}\ E_i^2/\rho_e$, where E_i is the first electron ionization potential in ev, and ρ_e is the number of outermost electrons per unit atomic volume a_0^3. In the H_2 and D_2 isotopes where E_i is constant, τ_1 is linearly dependent on ρ_e^{-1}. It was also found that τ_1 is independent of the ortho-para ratio of the liquid H_2 at 20.4°K. (auth)

708 MACH'S PRINCIPLE IN CLASSICAL AND RELATIVISTIC PHYSICS. Jaroslav Pachner (Technical Univ., Prague). Phys. Rev., 132: 1837-42(Nov. 15, 1963).

To investigate whether the reference frames remaining at rest relative to the expanding system of galaxies are also dynamically preferred, McVittie's metric describing exactly the field of a singular mass point in an expanding universe is transformed into a suitably chosen coordinate system. It is found that, in the Newtonian approximation, the potential governing the motion of a test particle is given by the sum of a Newtonian gravitational potential and of a cosmic potential which is composed additively by a scalar potential and by the scalar product of the velocity of the test particle and of a vector potential. The total energy of the test particle does not vary if, and only if, it is situated at the origin of a coordinate frame remaining at rest relative to the expanding system of galaxies. If the force acting on this particle should vanish, the origin of coordinates must coincide with the center of gravity of a field galaxy, or of a cluster of galaxies, respectively. If the Hubble constant of cosmic expansion varies with the time, the conservation law of energy does not hold in our neighborhood with infinite accuracy. The existence of the centrifugal and Coriolis forces, appearing also in the case when a single material body is rotating in an infinite absolutely empty space, is explained by the hypothesis that this empty space-time is to be considered for a Minkowski universe, i.e., a world model with infinite total mass and vanishing mean-mass density. Other exact solutions of the field equations of general relativity with a vanishing matter tensor which are free of singularities, if they actually occur in nature, are to be considered for self-excited states of the Minkowski universe. This assumption stands in a natural accord both with general relativity, and with the relativistic formulation of Mach's principle (expressed in the statement: The space-time does not exist without matter). It agrees also with the investigations of Hönl and Dehnen who proved that the centrifugal and Coriolis forces of correct magnitude appear in every reference frame which is rotating relatively to the total mass of the world model, and explains the Thirring forces as the result of the simultaneous action of the rotating mass of the near-hollow sphere and of the nonrotating distant mass of the Minkowski universe. From the standpoint of the proposed hypothesis, the cosmological constant is to be interpreted not as a universal natural constant, but as the 8π-multiple of the mean-mass density, written in a geometrical system of units, of a very strange and highly hypothetical form of matter the density of which, due to creation or annihilation of matter should remain constant during the expansion or contraction of the cosmic space. (auth)

709 OBSERVATION OF PARAMAGNETIC g-VALUE SHIFTS BY EXCHANGE INTERACTIONS. M. T. Hutchings and W. P. Wolf (Oxford Univ.). Phys. Rev. Letters, 11: 187-90(Sept. 1, 1963).

Exchange interactions in ionic magnetic materials in which the g-value shift is readily observable are reported. Experimental results for Yb^{3+} in $Tm_3Al_5O_{12}$ and $Tm_3Ga_5O_{12}$ are presented. (C.E.S.)

710 CALCULATIONS OF THE EFFECT OF ORBIT-LATTICE INTERACTION ON THE STATIC SUSCEPTIBILITY AND g FACTOR OF RARE EARTH COMPOUNDS. M. Inoue (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 11: 196-7(Sept. 1, 1963).

Corrections for the effect of orbit-lattice interactions on the static susceptibility of ytterbium gallium garnet and on the g-factor shift for Tm^{2+} and Ho^{2+} in CaF_2 at low temperatures were evaluated. Convergence of the perturbation development is quite good because of the absence of odd-order perturbations in the phonon amplitudes. The correction to the magnetic moment of the ground state is caused entirely by the admixture of excited states through the simultaneous action of both the Zeeman term and the orbit-lattice interaction. At low temperatures this correction arises primarily from the effect of zero-point lattice vibrations and is independent of temperature. (C.E.S.)

711 EUROPIUM ORTHOSILICATE, A NEW TRANSPARENT FERROMAGNET. M. W. Shafer, T. R. McGuire, and J. C. Suits (IBM Research Center, Yorktown Heights, N. Y.). Phys. Rev. Letters, 11: 251-2(Sept. 15, 1963).

The ferromagnetic properties of Eu_2SiO_4, which is optically transparent in the bulk, are presented. The values of the molar Curie constant, critical temperature, and magnetic moments are given. (C.E.S.)

712 ELECTRONIC SHIELDING OF THE CRYSTALLINE FIELD IN THULIUM ETHYL SULFATE. R. G. Barnes, E. Kankeleit, R. L. Moessbauer, and J. M. Poindexter (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 11: 253-5(Sept. 15, 1963).

The method of recoilless nuclear resonance absorption of gamma radiation was employed to investigate the temperature dependence of the nuclear quadrupole interaction in the 8.4-kev level of Tm^{169} in thulium ethyl sulfate. The experiment revealed a strong influence of electronic shielding resulting from the polarization induced in the closed electron shells by the crystalline electric field. (C.E.S.)

713 NUCLEAR MAGNETIC RESONANCE LINE NARROWING BY A ROTATING rf FIELD. Walter I. Goldburg and Moses Lee (Pennsylvania State Univ., University Park). Phys. Rev. Letters, 11: 255-8 (Sept. 15, 1963).

Nuclear magnetic resonance line narrowing was investigated by means of a rotating r-f field experiment that is analogous to free-induction decay in a rotating sample. A single crystal of uranium-doped calcium fluoride was used, and measurements were made at the same crystal orientation. An effective narrowing of the fluorine absorption line by a factor of 5 was obtained. (C.E.S.)

714 EFFECTS OF ROTATING MAGNETIC FIELDS ON FREE-INDUCTION DECAY SHAPES. D. Barnaal and I. J. Lowe (Univ. of Pittsburgh). Phys. Rev. Letters, 11: 258-60(Sept. 15, 1963).

The behavior of a set of particles in a rotating magnetic field is analyzed to determine how the lengthening of a nuclear magnetic resonance free-induction decay might occur. An experiment to determine the effect of pulse length on the subsequent free-induction decay was carried out for

gypsum, calcium fluoride, and ice. A single r-f pulse at the Larmor frequency of the spin system was applied to the sample in equilibrium and the resulting free-induction decay shape was recorded. The r-f pulse length was varied from 1 to 18 μ sec and the magnetic field ranged from 3 to 30 gauss. (C.E.S.)

715 LATTICE DYNAMICS OF NIOBIUM. Y. Nakagawa and A. D. B. Woods (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Letters, 11: 271-4(Sept. 15, 1963).

The frequency/wave-vector dispersion relation for symmetry directions in niobium was measured at 296°K by means of inelastic neutron scattering. Analysis of the data on the basis of the Born-von Karman theory indicates that the effective interatomic forces are of very long range. The Born-von Karman force model was also used to calculate the frequency distribution function. (C.E.S.)

716 SOME STOPPING POWERS FOR IODINE IONS. C. D. Moak and M. D. Brown (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 11: 284-5(Sept. 15, 1963).

The atomic stopping cross sections of Au, Ni, Al, and C for I^{127} ions in the energy range of 25 to 115 Mev were determined. (C.E.S.)

717 TRIPLET ENERGY TRANSFER AND TRIPLET-TRIPLET INTERACTION IN AROMATIC CRYSTALS. Joshua Jortner, Sang-il Choi, Joseph L. Katz, and Stuart A. Rice (Univ. of Chicago). Phys. Rev. Letters, 11: 323-6 (Oct. 1, 1963).

Triplet energy migration and triplet-triplet annihilation leading to fluorescence radiation are discussed. The molecular crystals considered are anthracene and naphthalene. Conclusions concerning the mechanism of the triplet-triplet annihilation, the recombination of the ion pair, and the rate-determining step in the triplet-triplet annihilation are outlined. (C.E.S.)

718 ELECTRON-NUCLEAR DOUBLE RESONANCE OF Ni^{61} IN Al_2O_3 AND VARIATION OF hfs THROUGH AN INHOMOGENEOUS LINE DUE TO RANDOM CRYSTAL FIELDS. P. R. Locher and S. Geschwind (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 11: 333-6 (Oct. 1, 1963).

The electron-nuclear double resonance spectrum of Ni^{61} in Al_2O_3 was measured and the absolute value of the Ni magnetic moment was determined to be 0.746 ± 0.007 nm. Inconsistencies in previous measurements of the magnetic moment were explained. It is shown that orbital hyperfine fields play a crucial role in nominally orbital singlet ground-state ions such as Ni^{2+}. A variation in hyperfine field was observed through an inhomogeneously broadened line. This arose from a variation of orbital hyperfine field in the different spin packets associated with slightly different axial crystal fields. (C.E.S.)

719 RESONANCE SCATTERING OF γ QUANTA IN CRYSTALS. S. L. Ginzburg (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 5: 1008-12(Nov. 1963).

An analysis is made of scattering of γ quanta in crystals taking into account both resonance scattering by nuclei and the interference between resonance scattering and scattering by electronic shells. The cross sections obtained are averaged over the spectrum of incident particles. (auth)

720 STUDIES ON X-AGENT. XXX. DISTANCE COVERED BY SECONDARY X-AGENT EMITTED FROM WATER OR LEAD. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 14: 127-43(June 1963).

Apparent transparency (transmittance) of the frosted surface of a glass vessel (the absorption cell for the Leitz-photometer) is occasionally affected by the secondary X-agent emitted from a substance when the cell is located close to the substance. On the basis of this phenomenon, using four cells arranged in a line in the north direction of a water bottle or of a Pb pile, the degree of the transmittance change of the frosted glass surface was examined. The results show that the cell placed closest to the water or to the Pb underwent the most striking change, showing that the effect of the secondary agent was strongest in the cell placed closest to the substance. On some experimental days even the cell placed farthest (30 cm from the substance) was affected, while on some days, although the cell placed closest to the substance was affected strikingly, almost no change could be demonstrated in the other cells. On some particular days, the change became stronger to some extent as the distance between the cell and the substance was greater. From this fact it is postulated that there may be at least two kinds of secondary agents, one of which is active only immediately after the emission from the substance, rapidly losing its strength, whereas the other of which can attain its strength some time after being emitted from the substance, and consequently can reach a long distance. In contrast to the absorption cell, a protein solution contained in a test tube would be affected even when no substance was placed close to it. This is believed to be attributable to the difference between the protein solution and the absorption cell in the sensibility to the X-agent. The absorption cell is likely to be sensitive solely to a particular sort of the secondary agent, so that it is affected only when placed close to a substance at some peculiar times. Therefore, the demonstration of the secondary agent emitted from a substance would be accomplished much easier with the absorption cell than with the protein solution. Since sea water is enormous in amount, the secondary X-agent produced by the water may be able to cover a great distance. This may account for the tidal- or the lunar-effect upon the organisms living near the sea. (auth)

721 ENHANCEMENT OF THE BREMSSTRAHLUNG PRODUCED BY 575-Mev ELECTRONS IN A SINGLE CRYSTAL OF SILICON. Arjun Nath Saxena. Thesis, Stanford, Calif., Stanford Univ., 1963. 93p.

Two experiments were performed to verify experimentally the enhancement of the soft component of the bremsstrahlung produced by high-energy electrons in a single-crystal target as predicted by Überall. In both the experiments, the energy of the electrons from the Mk III linear accelerator was 575 Mev, and a single crystal of Si was used at room temperature. The first experiment used the (100) plane of the Si single crystal. Photoproduction of π^+ mesons from a $(CH_2)_n$ target was used as a tool to detect photons of a given energy. Multiple scattering of the electrons in the Si crystal was measured and folded on the theoretical curve derived from Überall's calculations. Comparison of the experimental data with the folded curve indicated that the enhancement of the bremsstrahlung was not observed. The (110) plane of the Si single crystal was used in the second experiment. A double ion chamber was designed and constructed to monitor the bremsstrahlung beam, in which each half of the ion chamber was preceded by an appropriate thickness of Be converter. The ratio of the charges collected in the 2 halves of a double ion chamber was used to detect the enhancement of the bremsstrahlung. The data, presented in the form of a 3-

dimensional plot of the ratio vs the angles of rotation between the lattice normal and the electron beam about the horizontal and the vertical axes, clearly showed the enhancement. Detailed calculations were performed, and a quantitative comparison of the experimental result and the theory showed good agreement. (M.P.G.)

722 EXACT EMPTY-SPACE METRICS CONTAINING GEODESIC RAYS. Louis Anthony Tamburino. Thesis, Pittsburgh, Univ. of Pittsburgh, 1962. 65p.

Closed-form solutions are presented for several algebraic classes of empty-space metrics which contain geodesic rays (principal null directions of the Riemann tensor that are tangent to a congruence of null geodesics). The analytic method used is an application of the tetrad formalism developed by E. Newman and R. Penrose. All the solutions for the class of metrics containing non-shearing but curling geodesic rays are presented along with a non-existence theorem that restricts solutions of this type to be Petrov type-I degenerate. One of these solutions is of particular interest for it is a generalization of the Schwarzschild metric that appears to describe the gravitational field of a spinning particle. All solutions for the class of metrics containing shearing hypersurface orthogonal (non-curling) geodesic rays with non-vanishing divergence (Petrov type-I non-degenerate) are also presented. This latter class was found to yield a very restricted number of solutions without apparent physical interest. Other known empty-space solutions containing geodesic rays are those of Robinson and Trautman and of Kundt. These are rederived, using the Newman-Penrose formalism. (Dissertation Abstr.)

723 THE PHYSICAL STRUCTURE OF GENERAL RELATIVITY. D. W. Sciama. 24p. (CONF-303-4)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

The physical reality underlying the mathematical formulations of general relativity is sought. Specific examples are chosen for discussion (e.g., Mach's principle and the principle of equivalence). (T.F.H.)

Accelerators

Refer also to abstract 1021.

724 (AERE-R-4402) THE SENSITIVITIES OF SCINTILLATORS, IMAGE INTENSIFIERS AND TELEVISION SYSTEMS IN OBSERVING BEAMS OF NUCLEAR PARTICLES. P. Iredale (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1963. 11p.

Details of the scintillators, image intensifiers and television tubes that could be used in a system for viewing the profile of a beam of nuclear particles are presented, and the performance of several systems is given. The least sensitive system is a vidicon camera viewing a 2 cm thick plastic scintillator, which can be used in a flux of $\sim 2 \times 10^9$ minimum ionizing particles cm^{-2} sec^{-1}. High gain intensifiers plus an orthicon camera are sensitive to individual particles. Calculations show that an electroluminescent image intensifier panel should be useful for observing fluxes of $\sim 10^7$ minimum ionizing particles cm^{-2} sec^{-1}. (auth)

725 (CEAL-1006) THE EXTERNAL ELECTRON BEAM OF THE CAMBRIDGE ELECTRON ACCELERATOR. F. W. Brasse, G. E. Fischer, M. Fotino, and K. W. Robinson (Cambridge Electron Accelerator, Mass.). Sept. 1963. Contract AT(30-1)-2076. 12p. (CONF-114-19)

From The International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The resonant beam extraction system of Cambridge Synchrotron is described, and measurements of the extraction efficiency and extracted beam properties are compared with values predicted by calculations. (auth)

726 (DESY-A2.104) ZUR STROMBEGRENZUNG UND STRAHLZUSAMMENZIEHUNG BEIM ELEKTRONEN-SYNCHROTRON. (On Current Limitation and Radiation Focusing in Electron Synchrotron). A. Paulin (Deutsches Elektronen-Synchrotron, Hamburg). Aug. 1963. 6p.

Limitation by axial Coulomb repulsion of the accepted electron current in an electron synchrotron having 10^8 to 10^9 particles per bunch is examined. It is shown that the focusing properties of accelerating cavities suffice to contract the electron beam from 2.5 to 1.5 inch. (auth)

727 (JINR-P-1331) NELINEINYI REZONANS BETATRONNYKH RADIAL'NYKH KOLEBANII V SINKHROFAZOTRONE PRI CHASTOTE, RAVNOI 2/3. (Nonlinear Resonance of Radial Betatron Oscillations at a Frequency of 2/3 in the Synchrophasotron). V. I. Kotov, A. B. Kuznetsov, and N. B. Rubin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 11p.

The effect of the nonlinear resonance of the radial betatron oscillations due to the second harmonic of the magnetic field perturbation and occurring at a frequency of 2/3 in the synchrophasotron is analysed. Ion losses by multiple traversals of this resonance during the acceleration process are estimated. (auth)

728 (JINR-P-1340) ANALITICHESKII METOD RASCHETA FOKUSIROVKI CHASTITS DUBLETOM KRADRUPOL'NYKH LINZ. (Analytical Method for Calculating Particle Focusing by a Doublet of Magnetic Quadrupole Lenses). V. V. Miller (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 5p.

In the calculation of magnetic field gradients needed to focus the particles by a doublet of magnetic quadrupole lenses, a very precise expression is used for the sum of the focal lengths of a single lens ($f_+ + f_- = 1/3$, where l is the effective length of the lens). Assuming the principle planes of a lens to coincide with its center, a quadratic equation is obtained for f_1 and f_2. The error is $\lesssim 1\%$ even for $l/f \gtrsim 0.5$. A method is outlined for taking into account the finite distance between the principle planes and the center of the lens. (auth)

729 (JINR-P-1343) K RASCHETU FAZOVYKH SOOTNOSHENII V TSIKLOTRONE. (Calculation of Phase Relations in the Cyclotron). G. N. Vyalov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 7p.

A method for obtaining the phase motion in a cyclotron without complicated numerical calculations is described. It is based on the parabolic approximation of the magnetic field decrease in some radial sections. (auth)

730 (JINR-P-1349) OSNOVY ZASHCHITY OT IZDUCHENII USKERITELEI PROTONOV DEITRONOV I AL'FA-CHASTITS. (The Fundamental Aspects of Shielding from Radiation of Accelerators of Protons, Deuterons and Alpha Particles). M. M. Komochkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 85p.

The results of investigations of the problems of shielding against radiations from alpha particle, deuteron, and proton accelerators are summarized. Recent calculated and experimental data on shielding against gamma radiation from residual radioactivity are given. (64 references) (auth)

731 (LNF-63/62) STATUS REPORT ON THE 1.5-Gev ELECTRON-POSITRON STORAGE RING — ADONE. Note No. 212. F. Amman, R. Andreani, M. Bassetti, et al. (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Sept. 10, 1963. 16p. (CONF-114-18)

From the International Conference on High Energy Accelerators, Dubna, U.S.S.R., Aug. 1963.

The considerations (beam properties, focusing, interaction rate) that led to the design of the 1.5-Bev storage ring are outlined; and the design, properties, and development of the various storage ring systems are discussed. (D.C.W.)

732 (TID-19561) THE UNIVERSITY OF MICHIGAN 83-INCH CYCLOTRON. Progress Report, July 1–September 30, 1963. W. C. Parkinson and R. S. Tickle (Michigan. Univ., Ann Arbor). Oct. 1963. Contract AT(11-1)-921. 4p. (ORA-03763-13P)

Installation and modification of components of the facility continued, and methods for determining the performance of the beam preparation and analyzer magnets were developed and applied. New vacuum ducts for the beam preparation magnets were fabricated and installed because the original ducts failed to meet specifications. (D.C.W.)

733 (TID-19610) LINEAR ACCELERATOR PROJECT. Progress Report, July 1963–September 1963. E. R. Gaerttner (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 26p.

Modifications to the accelerator included installation of a switching magnet that provides five beams and of photoelectric klystron spark detectors. Solution of the monoenergetic transport equation in slab geometry showed that a real time decay constant exists for all slab thicknesses in die-away experiments. Relations were also derived that permit comparison of theoretical die-away parameters with experimental results. Water spectra were calculated by the Mass-1 gas and Nelkin models and were compared with experimental results. An examination of the validity of various approximations used to solve the monoenergetic time dependent transport equation demonstrated that the variational method has the advantage that it leads to the correct asymptotic time dependent characteristic in the thin slab limit. Pulsed-chopper measurements of the asymptotic scalar and surface spectrum for three multiplying assemblies were made. Improved resolution and background reduction were achieved in low-energy neutron inelastic scattering experiments; good data were obtained on vanadium for incident energies up to 1.7 ev. Data were also obtained for polyethylene at incident energies of 0.215 and 0.625 ev. (D.C.W.)

734 SINGLE ISOTOPE CALCIUM METAL TARGETS. Larry D. F. Allen (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 34: 941-2(Aug. 1963). (LADC-5782)

A method was developed for the preparation of single isotope calcium metal targets wherein the conversion of calcium carbonate to the metal and evaporation of the metal is a single operation. Calcium targets of 200 $\mu g/cm^3$ were prepared by the method on 30 $\mu g/cm^2$ carbon substrates for use in a cyclotron. (P.C.H.)

735 NONCOHERENT RADIATION DUE TO ELECTRONS IN A SYNCHROTRON AND SOME OF ITS APPLICATIONS. Yu. M. Ado. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 66-97(1963). (In Russian)

Experiments are described in which the properties of noncoherent radiation due to electrons accelerated in a synchrotron are investigated. The experiments were performed at the 280-Mev electron synchrotron of the Lebedeff Institute for Physics. An apparatus was constructed for the determination of optical radiation spectra arising from monoenergetic electrons during the complete acceleration cycle. The energy distribution of the radiation was determined for three electron energies, 150, 225, and 250 Mev. The intensity of various wavelength radiation was measured as a function of the electron energy from 70 to 280 Mev. The effect of the intensity on the number of electrons was found to be linear for 250-Mev electrons. Three applications are described for the electron optical radiation: the determination of the number of accelerated electrons, the measurement of the amount of electrons hitting a target during the acceleration process, and the determination of the azimuthal extent of the clots of accelerated electrons. (TTT)

736 THE 30-Mev ELECTRON SYNCHROTRON AT THE PHYSICAL INSTITUTE. V. I. Veksler, V. E. Pisarev, E. M. Moroz, and B. S. Ratner. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 98-150(1963). (In Russian)

The 30-Mev electron synchrotron in operation at the Lebedeff Institute for Physics is described. The magnet, the determination of the magnetic field as a function of time, and the magnetic characteristics of the accelerator are described. The amplitude and phase asymmetries of the magnetic field and the magnetic field fall-off with radius are discussed. The position of the equilibrium orbits is also also described. An experiment is discussed, which is designed for the determination of the shape of the magnetic field in the synchrotron air gap. The intensity of the accelerated electrons was measured as a function of the: position of the injector, magnetic field symmetry, injector voltage, injector current, injection time, electric field inside the vacuum chamber, and frequency of the magnetic field. The electron energy was measured and the angular distribution of the emitted gamma radiation was determined. The accelerator radiofrequency system and the electric supply system for the magnet are described. (TTT)

737 DEPENDENCE OF THE GAMMA-RAY INTENSITY IN THE BETATRON ON THE BASIC PARAMETERS OF THE INTERNAL INJECTION OF ELECTRONS. V. N. Lugunov and S. S. Semenov. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 151-7(1963). (In Russian)

The effectiveness of internally injecting electrons into a betatron was investigated. A specially designed internal injector was constructed, whose electron-optical system consisted of three electrodes: a cathode, a focusing electrode, and an anode. The performance of the internal injector was then compared with that of an external injector which possessed the same electron-optical system. Both injectors were placed in the vacuum chamber at the medium plane and at the same distance away from the equilibrium orbit. The measurement of the intensity of the bremsstrahlung radiation showed that for the same injection parameters the intensity obtained from internal injection was the same as that obtained from the external injector. (TTT)

738 STABILIZATION OF THE ELECTRON ENERGY IN THE 30-Mev SYNCHROTRON. M. V. Karpov, E. P. Obchinnikov, and B. S. Ratner. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 158-66(1963). (In Russian)

A stabilization system is described for use in the 30-Mev electron synchrotron of the Lebedeff Institute for Physics. A block diagram is shown for the system. Circuit diagrams are displayed for each of the following component parts: integrator and discriminator; commutation

scheme for the resistor magazine, which is used to determine the energy; the impulse amplifiers, which determine the start and finish of the triggering mechanism; generator for the production of sinusoidal oscillations; trigger mechanism; rectifier circuit for feeding the stabilization blocks; and control scheme for the pulse formation at zero amplitude of the sinusoidal wave. The stabilization was checked at various times by studying the position of the bend in the yield curve at 17.25 Mev of the reaction $O^{18}(\gamma,n)O^{15}$. It was found that the system remained stable, ΔE = 20 to 30 kev for periods of several months. An energy calibration curve was obtained for the stabilization system by studying six reactions whose thresholds are known. (TTT)

739 STUDIES OF CERTAIN PROTON-TARGET AND DEUTERON-TARGET REACTIONS IN THE ENERGY RANGE OF 0.1 TO 0.6 Mev. Earl Morrow Sawyer. Thesis, Gainesville, Fla., Univ. of Florida, 1960. 89p.

The various methods of calibrating the energy of the beam of charged particles from a Van de Graaff accelerator were discussed, in particular the 3 methods making use of the generating voltmeter, magnetic deflection of the beam, and known nuclear resonances. The University of Florida Van de Graaff accelerator was calibrated making use of the 3 methods listed and comparing each with the other. The nuclear resonances used were the 334-kev resonance from the $F^{19}(p,n)Ne^{20}$ reaction and the 441-kev resonance from the $Li^{7}(p,n)Be^{8}$ reaction. It was concluded that the generating voltmeter method was the most convenient; the magnetic deflection of the beam, using the proton resonance method to measure the magnetic field of the analyzer magnet, was the best and most accurate method; and the nuclear resonance method may be used to serve as a check on the other two. The University of Florida Van de Graaff accelerator was used to accelerate deuterons into a deuterium target. One of the results of this is the $d(d,n)He^{3}$ reaction. The distribution of the neutrons from this reaction, at various angles and for a number of different energies of the incident deuterons, was investigated. The results of this are reported and compared to similar experiments done elsewhere. (Dissertation Abstr.)

Astrophysics and Cosmology

740 ISOTOPES RESEARCH BY SPECTROSCOPY IN STAR ATMOSPHERES. G. Righini (Osservatorio Astrofisico di Arcetri, Florence). Met. Ital., 55: 371-4(Aug. 1963). (In Italian)

The spectroscopic effect of isotopes on line and band spectra are briefly exposed; then the situation with regard to the knowledge and amount of light element isotopes in the sun and stars is summarized. From experimental results some consequences are deducted concerning the equilibrium condition of star masses and of the nuclei formation processes inside the stars. (auth)

741 FIRST METEOROID-PENETRATION DATA FOR SNAP DESIGNERS. Charles T. D'Aiutolo (National Aeronautics and Space Administration, Washington, D. C.). Nucleonics, 21: No. 11, 51-5(Nov. 1963).

Data are presented from the latest experiments on meteoroid penetration from Explorer XVI. The results show that the probability of penetrating metal sheets with thicknesses around 0.0025 cm is considerably less (10 to 100 times) than designer estimates. (R.E.U.)

Atomic Physics

742 (AD-298614) ANGULAR ENERGY DISTRIBUTION OF PHOTOELECTRONS. Quarterly Progress Report, April 16–July 16, 1962. (Chicago. Univ. Labs. for Applied Science). Aug. 1, 1962. Contract DA-44-009-eng-5004. 20p. (LAS-SR-224-4)

The general features of an experiment to measure the angular energy distribution of photoemission from Sb–Cs photocathodes are reviewed, and the apparatus for the experiment is described. (auth)

743 (CONF-254-1) SOME STUDIES ON THE LUMINESCENT CENTERS IN ZINC SULFIDE TYPE PHOSPHORS. Technical Report, Series A, No. 25. Shigeo Shionoya, Takao Koda, Koh Era, and Hiroko Fujiwara (Tokyo Univ. Inst. for Solid State Physics). Sept. 1961. 53p.

From 1961 International Conference on Luminescence, New York, Oct. 1961.

In the investigations on the luminescence of zinc sulfide type phosphors, the nature of the various centers as well as of electronic transitions responsible for the luminescence are the most fundamental and interesting problems. Some results concerning these problems hitherto obtained in this laboratory are mentioned. Three problems are considered: (I) nature of the load center, (II) energy transfer from lead to manganese centers, and (III) nature of the copper red center. (auth)

744 (NP-13274(p.7-8)) SURFACE AND ATOMIC PHYSICS. F. Propst, H. Boehmer, T. Cooper, T. Piper, G. Tibbetts, H. Fraunfelder, and F. Franz (Illinois. Univ., Urbana. Coordinated Science Lab.).

Small stray magnetic fields were found, apparently, to cause non-negligible errors in the measurements of the angular distribution of electrons ejected from the surface of a single crystal W ribbon by low-energy ions. The heating characteristics in vacuum of a W ribbon were measured, and the emission of photons in reactions of low energy (25 to 100 ev) He ions with a W surface was experimentally observed. Preliminary measurements indicated relaxation times of 40 to 400 msec for optically pumped Cs vapor in various buffer gases. (D.C.W.)

745 (PAN-383/II) DISPERSION RELATION FOR SPIN WAVES IN $CuFeS_2$. A. Murasik (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Dec. 1962. 11p.

The spin wave dispersion relation of $CuFeS_2$ is derived. The possibility of experimental varification by the method of inelastic scattering of neutrons is discussed. (auth)

746 (PAN-448/XVIII) CLASSICAL THEORY OF ATOMIC COLLISIONS. I. INELASTIC ATOMIC COLLISIONS. Michal Gryzinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 90p.

On the basis of the relations for binary collisions as well as for the Coulomb collisions, derived in the laboratory system of coordinates, a classical theory of inelastic atomic collisions is derived. Built up as an approximation of the binary collisions, i.e., of the independent pair interaction of the individual elements of the colliding systems, the theory, with its immense simplicity, not only permits a clear qualitative interpretation of the atomic collisions, but also describes well their quantitive aspects. Basic inelastic processes accompanying the atomic collisions are analyzed in terms of the theory. (auth)

747 (NP-tr-1068) THE EFFECT OF ION BOMBARDMENT ON METAL SURFACES. Fritz Hilbert (Germany. Zentralinstitut fur Kernphysik, Dresden). Translated by G. G. Kinnane (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.). July 1962. 44p.

Collision processes in which the angle between the impact direction and the lattice axis for successive impacts between individual atoms in the lattice line is reduced are called focusing collision processes. Methods for detecting such processes and results obtained with them are reviewed, and the focusing processes possible in different types of crystal structure and their influence on surface erosion effects are discussed. Experimental results obtained by bombarding metals with fcc, bcc, and hcp structures (Ni, Fe, and Zn) with Ar ions are presented and discussed. (D.C.W.)

748 BINARY MIXTURES OF DILUTE BOSE GASES WITH REPULSIVE INTERACTIONS AT LOW TEMPERATURE. David M. Larsen (National Bureau of Standards, Washington, D. C.). Ann. Phys. (N. Y.), 24: 89-101(Oct. 1963).

It is shown that a mixture of dilute hard-sphere Bose gases of different particle mass phase separate at zero temperature. For more general short range repulsive interactions for which no phase separation occurs the excitation spectrum is computed. (C.E.S.)

749 ON THE EMISSION AND ADSORPTION OF γ-RAYS BY AN IMPURITY ATOM IN A CRYSTAL. I. Waller. Arkiv Fysik, 24: 495-502(1963).

An exact formula is derived for the elastic and inelastic Mössbauer effect of an impurity atom assumed to be substituted for an atom in a periodic host lattice. The forces between the atoms are supposed to remain the same as in the host lattice. Cubic symmetry is assumed to exist with respect to the impurity site. (auth)

750 ANGULAR DISTRIBUTIONS OF PHOTOELECTRONS EJECTED FROM URANIUM BY 158 kev AND 208 kev GAMMA RAYS. W. F. Frey, J. H. Hamilton, and S. Hultberg (Vanderbilt Univ., Nashville). Arkiv Fysik, 24: 503-10(1963).

K, $L_I + L_{II}$, and L_{III} photoelectric angular distributions were studied experimentally for uranium at gamma-ray energies 158 and 208 kev (K shell only at the latter energy). The K and $L_I + L_{II}$ distributions show similarities but the L_{III} distribution was found to exhibit a much stronger preference for forward emission of the photoelectrons. The following ratios were found at the 158 kev gamma-ray energy: $(\tau_K/\tau_{L_I+L_{II}}) = 6.3 \pm 0.5$; $(\tau_K/\tau_L) = 5.0 \pm 0.4$; and $(\tau_{L_I+L_{II}}/\tau_{L_{III}}) = 3.9 \pm 0.4$; where $L = L_I + L_{II} + L_{III}$. (auth)

751 SPUTTERING OF SILVER BY IONS OF NOBLE GASES. A. V. Narasinham and S. B. Karmohapatro (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 37: 394-400(July 1963).

Sputtering yields of silver in collision with the ions of noble gases at energies from 3 to 7 kev were determined by a tracer method. Angular distribution of the sputtered atoms of silver was measured. Results are discussed and compared with the existing theories. (auth)

752 THE PROBABILITY OF ENERGY EXCHANGE IN ATOMIC COLLISIONS UNDER ACCIDENTAL RESONANCE CONDITIONS. E. E. Nikitin. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 996-8(Aug. 1963). (In Russian)

The dependence of the atomic and molecular energy exchange cross sections on the energy of the colliding particles and the resonance energy may be examined often by evaluating only 2 terms. The probability of nonadiabatic transitions between the particles may be calculated from the intermolecular potential either on the basis of a quasi-classical solution of a system of 2 interrelated wave equations, which define the relative motion of the nucleus, or by the perturbation theory. In order to determine quantitatively the dependence of the interacting matrix element on the interatomic distance R and the change in the nonadiabatic transition probability on the resonance defect ΔE, the nonadiabatic transition between the 2 terms was considered. It was found that the s-p transitions between the terms possess a basically dynamic character. Equations were derived for expressing the decrease of the matrix element in the case of collisions involving energy exchange; it is expected to decrease exponentially with the distance, as in the case of s-s transitions. The method was found suitable for calculating the probability of the energy exchange. (TTT)

753 CHARGE EXCHANGE OF ATOMS AND IONS OF ALKALI AND ALKALINE EARTH ELEMENTS. D. B. Chkuaseli, A. I. Guldamashvili, and U. D. Nikoleishvili (Physico-Technological Inst., Georgian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 999-1004(Aug. 1963). (In Russian)

Charge exchange cross sections were measured by the so-called potential method (Phil. Mag., 40: 369(1949)) for symmetrical ion-atom pairs for which resonance defect values were the same but signs were opposite. For exothermic processes, the cross sections, of the order of 10^{15} cm^2, generally increased with increasing velocity of the primary ion from 1×10^{-7} to 4×10^{-7} cm/sec for the pairs $Rb^+ \rightarrow Cs$, $K^+ \rightarrow Cs$, $Na^+ \rightarrow Cs$, $Ca^+ \rightarrow Cs$, and $Mg^+ \rightarrow Cs$ and for the endothermic processes, $Cs^+ \rightarrow Rb$ and $Cs^+ \rightarrow K$. The $Na^+ \rightarrow Cs$ value began to decline at about 4.5×10^{-7} cm/sec. At a constant primary ion velocity of 1.6×10^7 cm/sec, the plot of cross section ($Cs^+ \rightarrow Cs$) vs resonance defect showed a larger cross section for exothermic (positive resonance defect) processes than for endothermic (negative). This indicated that the cross section depends not only on the value of the resonance defect and the velocity of the primary ion, but also on the sign of the defect. Results were reproducible to ±16 per cent except for $Cs^+ \rightarrow Na$, for which ±30% was observed. (TTT)

754 CALCULATION OF NON-RESONANCE ENERGY EXCHANGE AND IONIZATION OF ATOMS IN THE CASE OF THEIR COLLISION WITH SLOW IONS. V. I. Rydnik and B. M. Yavorskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1005-8(Aug. 1963). (In Russian)

The main feature of the theory of the resonance energy exchange under the influence of slow ions consists in the introduction of the effective radius R_0, defined by the value of an indicator parameter, at which the average exchange probability becomes equal to $\frac{1}{2}$. An attempt was made to extend the theory for cases of non-resonance exchange and ionization of atoms colliding with slow ions. As the conditions of the adiabatic motion of the ions in Coulomb interactions coincided with those required by quasi-classical behavior, O. B. Firsov's quasi-classical approximation (Zh. Eksperim. i Teoret. Fiz., 21: 1001(1957)) was used for the calculations. The values obtained were compared with N. V. Fedorenko and V. A. Belyaev's experimentally determined data (Zh. Eksperim. i Teor. Fiz., 37: 1808 (1959)). The probability of energy exchange of diatomic molecules was found to be identical, indicating a good agreement between theoretical and experimental data. Ionization of atoms by collision with positive ions ap-

peared to correspond to non-resonance energy exchange, even though the adiabatic character of the ionic motion might be difficult to ascertain. The derived computation method might be useful for estimating the value and the energy dependence of certain collision cross sections involving the interaction of slow ions and atoms. (TTT)

755 ELECTRON LOSSES BY FAST ATOMS OF CALCIUM, MAGNESIUM, SILICON, AND IRON COLLIDING WITH NITROGEN AND OXYGEN MOLECULES. A. M. Bukhteev and Yu. F. Bydin (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1009-11 (Aug. 1963). (In Russian)

Study of low-energy atomic collisions may be useful for clarifying the mechanism of ionization of air by meteors. In addition to the neutral atoms, lines belonging to Ca^+, Mg^+, Si^+, and Fe^+ ions were observed in the optical spectra of meteor tracks. The excitation and the ionization of these tracks are due to the collision of fast moving atoms from the surface of the meteor with molecules of the atmospheric gases. The ionization of fast alkali metal atoms colliding with N_2 and O_2 molecules at energies ranging from 100 to 2000 ev was previously investigated (Zh. Tekhn. Fiz., 11: 444(1948)). This study was extended to fast atoms of Ca, Mg, Si, and Fe for the purpose of determining the effect of ionization cross section of their collision with the N_2 and O_2 molecules. A positive-ion beam from a mass monochromator was directed onto a chamber filled with aniline vapors; as a result of the energy exchange the fast ions were transformed into fast atoms. The electron current resulting from the reaction, e.g., $\vec{Ca} + N_2 \rightarrow \vec{Ca}^+ + e + N_2$ was measured. The ionization cross section values obtained were of the same order of magnitude (10^{-17} to 10^{-16} cm^2) as those reported by D. U. Sida for Ca and Ne. The values, calculated with an estimated error of ±20%, are presented in tabular form. (TTT)

756 EMPIRICAL FORMULAS FOR THE EFFECTIVE EXCITATION AND IONIZATION CROSS SECTIONS. I. Beigman and L. Vainshtein (Lebedev Inst. of Physics, Moscow) Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1018-21(Aug. 1963). (In Russian)

In view of the complexity of the needed measurements and calculations, effective excitation and ionization cross sections must often be determined by using empirical formulas; these relatively simple expressions are useful for estimating plasma processes. The formulas proposed by various authors for use in the case of the collision of atoms with electrons are reviewed. The formulas are expected to give the order magnitude of the cross section, i.e., its maximum and its dependence on the energy of the external electron. The parameters used in the formulas include the ionization and excitation threshold energy and the energy of the external electron, together with a proportionality factor referring to the number of equivalent electrons in the shell in which the process takes place. Quite often, instead of the cross section, the average Maxwellian transition frequency must be calculated. In the case of collisions with heavy particles, such as protons, the adiabatic effect must be taken into account. (TTT)

757 INTRODUCTION OF THE POLARIZATION POTENTIAL INTO THE RADIAL EQUATIONS OF THE ATOMIC COLLISION THEORY. L. Vainshtein (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1022-6(Aug. 1963). (In Russian)

Calculation of the effective cross section of electrons colliding with atoms and ions requires the solution of an infinite system of multiconfigurational integral–differential equations. If the system is limited to 2 equations, it is possible to estimate the effect of the wave distortion caused by the field of the atom and to calculate the relation between the initial and the final levels. In order to increase the accuracy of the values, the polarization of the atom must be taken into account. In order to accomplish this, the system of radial equations was transformed into 1 or 2 equations, which also included the polarization potential. The radial functions are thus defined by 2 equations comprising a set of quantum numbers of the system which consists of the atom and the external electron. The polarization potentials were used primarily as a correction in the approximation but in some cases, better results were obtained by introducing the polarization potentials directly into the differential equations. The handling of elastic and inelastic scattering phenomena is illustrated by examples. (TTT)

758 CALCULATION OF THE COLLISION OF SLOW ELECTRONS WITH HYDROGEN ATOMS, USING THE TRIAL FUNCTION METHOD. V. T. Murav'ev (Moscow Textile Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1030-2(Aug. 1963). (In Russian)

V. D. Kamenetskiĭ's quantum-mechanical method, based on trial functions (Opt. i Spektroskopiya, 9: 111(1960)) was used for calculating the collision of slow electrons with H atoms, with and without taking exchange phenomena into account. Attempts were made to increase the accuracy of the data obtained by the method. The values obtained were found to lie very close to those computed by numerical integration. The average accuracy of the wave function was considerably higher than that of wave functions derived by variation methods. The calculations also indicated that a combination of the two methods described by Kamentskiĭ (Izv. VUZ, Fizika, 42(1961) No. 3; ibid. 134(1961) No. 5) is simpler than the variation methods but still yields more accurate results. (TTT)

759 NEW DEVELOPMENTS IN THE EXPERIMENTAL EXCITATION RESEARCH TECHNIQUES FOR ELECTRON-ATOM COLLISIONS. I. P. Zapesochnyi and O. B. Shpenik (Uzhgorod State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1033-6(Aug. 1963). (In Russian)

Previous studies of the effective excitation cross section of electron-electron collisions indicated that the fine structure may be determined from the dependence of the intensity of the spectral lines on the velocity of the exciting electrons. Such investigations were carried out to study the effect of a monokinetic, 0.6 to 1-ev electron beam on the spectral lines of Zn, Cd, Na, and He. In these studies of the optical excitation function the "quasi-monochromatization" method was used; the method involves placing an electrode in the path of the electron beam. This electrode lets through only the electrons which possess a potential higher than its own. The spectral lines were then further examined by means of a special spectrograph provided with a photomultiplier and amplifier system connected to a sensitive microammeter. The excitation functions of the most intensive lines of the visible triplets of Zn (λ = 4811 Å), Cd (λ = 5086 Å), and Hg (λ = 5461 Å) were measured. The excitation functions of the Zn lines were found to agree well with earlier data (Vestnik Leningr. Univ., No. 11, 67(1954) and with the values reported by Larche (Z. Phys., 67: 440(1931)). The initial portion of the excitation function of the same Hg line, excited at ΔV = 0.18 ev was found to exhibit a number of large maxima. (TTT)

760 THE EXCITATION FUNCTIONS OF THE ATOMS OF CERTAIN ALKALI METALS. I. P. Zapesochnyi and L. L. Shimon (Uzhgorod State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1037-9(Aug. 1963). (In Russian)

Experimental difficulties prevented the determination of the cross section and of the excitation function of the alkali metals; a systematic study was therefore started to investigate the processes involved in the excitation of alkali metals by electron impact. In order to increase the sensitivity of the usual photographic and photoelectric methods, a photomultiplier with electrometric amplification was used for recording. The vapor pressure of the metals studied was so chosen that they did not interfere with the measurements. The monokinetic character of the electron beam was considerably improved, keeping the energy variation within 0.5 to 0.8 ev. The excitation functions of Na, Rb, and Cs were determined. It was found that the excitation curves of the resonance lines exhibit broad maxima, followed by a slow decrease of the intensity. These broad maxima are probably mostly due to cascade transitions. The behavior of the excitation functions of the spectral components which belong to the same doublet, were found to be identical, regardless whether the upper or lower levels are different. This confirmed the findings of L. M. Volkova (Opt. i Spektroskopiya, 7: 819(1959); ibid. 13: 849(1962)) with Cd; on the other hand, I. P. Bogdanova who investigated the second doublet of the main series of Cs (λ = 4555 and 5493 Å) (Izv. Akad. Nauk SSSR, Ser. Fiz., 24: 956(1960) No. 8) found that the curves did not coincide and the maxima were shifted with respect to each other. (TTT)

761 NEW DATA ON THE EXCITATION FUNCTION OF INERT GASES. I. P. Zapesochnyi and P. V. Fel'tsan (Uzhgorod State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1040-3(Aug. 1963). (In Russian)

Experimental data were determined for the excitation lines in the visible, ultraviolet, and near-infrared regions for He(I), He(II), and neon. The lines were recorded by a photoelectric method. The measurements were made at current densities in the electron beam of 1×10^{-4} amp/cm^2, gas pressures of 2×10^{-3} mm Hg, and electrons of 0.65 to 0.75 ev for 90% of the beam. The data are given in tables. Curves are also plotted for line intensities versus electron energy in the excited state. Together with other results they give a more accurate idea about the course of the excitation function for the different members, and especially for the most important members, the main lines of the series. There are too few data for conclusions to be drawn. (TTT)

762 THE FINE STRUCTURE OF THE OPTICAL EXCITATION FUNCTIONS OF THE ZINC, CADMIUM, AND MERCURY ATOMS. I. P. Zapesochnyi and V. S. Shevera (Uzhgorod State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1044-8(Aug. 1963). (In Russian)

Findings on the fine structure of the excitation lines of Hg in the visible range were reported earlier (Dokl. Akad. Nauk SSSR, 55: 917(1954)). It could be expected that the lines of Zn and Cd will exhibit a similar behavior. In view of the scarcity of data, the excitation functions of these elements were investigated in the visible, ultraviolet, and near infrared range, using an excitation tube, a spectral apparatus and with a monochromator and a photoelectric photometer for the studies. The measurements with Zn and Cd had to be carried out at temperatures between 220 and 350°C; the vapor pressure was kept between 8×10^{-4} and 1.5×10^{-3} mm of Hg, while the current density used was less than 1×10^{-3} amp/cm^2. The electron velocity was kept within 0.9 to 1.2 ev, reaching 0.6 to 0.7 ev in a few cases. A number of singlets and triplets of Zn, Cd, and Hg was investigated, and the fine structure maximum in the excitation function maxima determined. The results indicated that the excitation cross section of the spectral lines reach a maximum very rapidly; the triplet lines exhibit an even more abrupt increase. Most of the fine structure maxima may be attributed to cascade transitions to the upper levels of the lines; however, some of the secondary maxima do not seem to be connected with cascade transitions. It may be assumed that at least for some of the excitation curves, the first 2 closely lying maxima are characterized by the same high-level excitation functions. (TTT)

763 STUDY OF THE CARBON DIOXIDE BAND IN ELECTRON EXCITATION. S. M. Kishko and V. V. Skubenich (Uzhgorod State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1049-51(Aug. 1963). (In Russian)

From results of previous studies of the optical excitation functions of N_2^+, CO^+, and NO^+ bands (Dokl. Akad. Nauk SSSR, 134: 311(1960)) it was concluded that their structure is determined by the elementary processes that take place in the discharge tube when these gases are excited by slow electrons. The work was extended to an investigation of the CO_2 band in the visible range, using electron excitation for the purpose of verifying the previous interpretation of the data in the case of a triatomic molecule. In this study the experimental technique, developed for the examination of diatomic molecules (Opt. Spektroskopiya, 6: 580(1959)) was again used. The discharge tube was filled with CO_2, prepared by the vacuum decomposition of $ZnCO_3$, while a monokinetic electron beam was employed for the excitation. At a pressure of 0.7×10^{-3} mm of Hg, the mean free path of the electrons in the CO_2 was more than 2 cm, which was higher than the distance between the accelerating anode and the electron receiver. The CO_2 was found to poison the oxide cathode when the energy of the exciting electrons exceeded about 80 ev. The emission spectrum of CO_2, excited by a 17 to 28-ev electron beam, was determined within the range of 4000 to 5300 Å. It was found that even at 19 ev, in addition to the CO_2, the emission spectrum shows the presence of CO, CO^+, and CO_2^+ bands. This indicates that even at this energy level processes causing dissociation and ionization take place in the CO_2. The maxima of the excitation curve λ = 4281 Å were found to differ from the previously determined curves of the CO and CO^+ bands. (TTT)

764 DETERMINATION OF THE EFFECTIVE EXCITATION CROSS SECTION OF THE RESONANCE LINES OF POTASSIUM ATOMS. L. M. Volkova and A. M. Devyatov (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1052-5(Aug. 1963). (In Russian)

The total effective excitation cross section of the two components of the resonance lines of potassium was found to be 1.32×10^{-14} cm^2. This is in good agreement with published experimental and theoretical values of 2×10^{-4} and 0.8×10^{-14} cm^2, respectively. The value was obtained under conditions of low resonance absorption by a photographic photometry method. A special tube was constructed in which the distance from the center of the excited beam of potassium atoms to the exit port of the tube was approximately 1 mm Hg (temperature of 72°C). Assuming that the lines of emission and absorption had the same Doppler contour, which was proved experimentally, the absorption in the center of the line and the total absorption were estimated by calculation. The resonance was decreased no

more than 5% by self-absorption at the tube exit. The suggestion that a charge on the glass could result in dispersion of the beam was confirmed by the loss of shape of the beam after 10 to 20 min operation of the tube. The maximum error in the measurements was ±35%. (TTT)

765 THE POSSIBILITY OF MEASURING THE OPTICAL FUNCTIONS OF EXCITATION BY A MODULATED ELECTRON BEAM. I. P. Bogdanova and I. I. Geitsi. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1056-9(Aug. 1963). (In Russian)

An attempt was made to clarify the conditions under which the "retarding potential difference" method (Rev. Sci. Instr., 26: 1101(1955)) may be used for studying the excitation function. The complexity of the 5461 Å line in the mercury spectrum, with internal modulation, was examined. At 5-mv amplitude of modulation, the curve had many peaks, which flattened out with increasing amplitude up to 800 mv. In the 50-mv curve, which showed the fine structure most clearly, the first maximum was the best separated from the others, and the fifth peak showed a structure not observed in earlier work. If it is assumed that the fine structure resulted with each transfer from an upper level to a lower, the resolved peak may be ascribed to a cascade transfer from the levels $10^3\underline{P}_{012}$, $11^3\underline{P}_{012}$, and $12^3\underline{O}_{012}$. Measurements were also made on the 4916-, 4358-, and 4047-Å lines, and curves are shown for them. (TTT)

766 METHOD OF MEASURING THE EFFECTIVE IONIZATION CROSS SECTION AND IONIZATION COEFFICIENT OF METAL ATOMS IN AN ELECTRON IMPACT. A. P. Lyubimov, S. I. Pavlov, V. I. Rakhovskii, and N. G. Zaitseva. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1060-4 (Aug. 1963). (In Russian)

The method for making the measurements consists in ionization of an atom beam of the studied metal by a perpendicular beam of monoenergetic electrons. The ions formed are collected and the current thus generated is measured. The unionized ions in the beam are condensed and measured gravimetrically and chemically, or radiologically in the case of tagged atoms. A special glass tube was constructed in the shape of a cross with three ground-glass joints. In one glass stopper was mounted the atom-beam-forming (heated) unit; in the second, perpendicular to the first, was the electron irradiation unit; and in the third, a Dewar vessel connected to the detachable ion collector. The vacuum in the tube was 5×10^{-6} mm Hg. The tube was cooled by flowing water. Silver was studied because its vapor tension is sufficient at the experimental temperature of 1300°K, it can be obtained in 99.99% purity, it is a relatively noble metal, and its isotope Ag^{111} has a half life of 225 days, which is convenient for determining beta and gamma spectra. The samples studied had a total activity of 0.1 mc. The values obtained in this apparatus were substituted in equations and the desired values were thus determined. (TTT)

767 ESTIMATION OF THE ABSOLUTE VALUES OF THE EFFECTIVE CROSS SECTIONS OF SECOND-ORDER COLLISIONS FOR MIXTURES OF SODIUM AND MERCURY VAPORS. S. E. Frish and O. P. Bochkova. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1065-9(Aug. 1963). (In Russian)

The study of the luminescence of Na + Hg vapor mixtures represents a useful tool for determining the absolute value of the effective cross section of second-order collisions. The Na atoms may be excited by 2 processes: first-order collisions with electrons and second-order collisions with excited Hg^* atoms, assuming the Hg possesses only 1 excited state. Measurements were carried out with Na–Hg mixtures excited by a high-frequency discharge in a Mo glass tube provided with external electrodes. The largest second-order excitation may be expected at the 6P, 7S, and 6D levels of Na for collisions with Hg at the 6^3P_0 state and at the 8S, 7D, 7F, 8P, 9S, 8D, 8F, and 9P levels for collisions with Hg atoms at the 6^3P_1 state. The absolute intensities of the secondary Na lines were measured photoelectrically by comparing them with the continuous band spectrum used for calibration. It was found that the concentration of the excited Na atoms increases markedly when passing from the luminescence of the pure Na atoms to that of Na + Hg. The population of the 7S, 9S, 6D, and 6P levels increased especially strong. The concentration of the normal Na atoms, $N_0(Na)$, determined by the anomalous dispersion method, was found to lie between 0.5 and 1.0×10^{13} cm^{-3}. The effective cross section of the second-order collisions was large even at excitation energies of a few hundred ev, making it possible to populate selectively the individual levels in the atoms and to obtain negative values for the absorption coefficients. (TTT)

768 SPIN EXCHANGE. E. B. Aleksandrov, A. M. Bonch-Bruevich, and V. A. Khodovoi. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1070-7(Aug. 1963). (In Russian)

Spin exchange is defined as the change of the angular momenta of particles, in the excited or the ground state, as a result of collisions. Study of the optical orientation showed that a nonequilibrium, ground-level half-state distribution of atoms may be obtained; the optical orientation may be useful for detecting very small changes in the distribution under the influence of specific agents, such as the resonance radiofrequency field. Radiospectroscopy and the study of optical orientation open up new approaches for determining angular momenta and thus of the spin exchange. In the modern spin exchange theory it is assumed that under certain reciprocal orientations of the electron momenta of the colliding atoms, quasi-molecules are formed. In most previous studies the optical orientations of the atoms after the collision were determined. The measurements are complicated by the fact that in most cases the orientation is only partial and the resonance light beam is not completely monochromatic. Spin exchange was used for carrying out isotopic analyses. The method is considered to be useful for obtaining more accurate values for the molecular constants. (TTT)

769 DEPENDENCE OF THE AVERAGE CHARGE ON FAST IONS ON THE DENSITY OF THE MEDIUM. V. S. Nikolaev, I. S. Dmitriev, Ya. A. Teplova, and L. N. Fateeva. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1078-80(Aug. 1963). (In Russian)

The increase in average charge with increasing gas density, at pressures from 4×10^{-5} to 5×10^{-2} mm Hg, was observed for nitrogen ions (velocity 8.2×10^8 cm/sec, energy 4.9 Mev). The triply charged nitrogen ions accelerated in the cyclotron chamber had collision lengths of 4.8 meters and diameters of 10 cm. With increasing pressure from 10^{-3} to 10^{-2} mm Hg, the average charge increased 7%. This is related to the fact that the average lifetime between collisions in which electrons are lost is comparable to the lifetime of the excited state of the nitrogen ion. Gas at 10^{-2} mm Hg is not sufficiently rarefied, and the average charge on the ions at this pressure may be significantly different from the average in less dense mediums. Data must therefore be corrected to account for this difference. (TTT)

770 THE PROBABILITY OF THE IMPACT EXCITATION OF VIBRATIONS IN DIATOMIC MOLECULES.

N. A. Generalov and S. A. Losev (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1110-12(Aug. 1963). (In Russian)

The relaxation times of the vibration energy in a broad temperature range up to 10,000°K were measured by determining the distribution of the vibration-excited 0 behind a strong shock wave (Vestn. Mosk. Univ., III: No. 2, 52 (1962)); under the conditions used, multiquantum transitions became marked beyond 6000 to 7000°K. This work was continued by reviewing the results obtained up to 7000°K, assuming that the excitation of the vibrations is due to single-quantum transitions. The factors considered included the nature of the bombarding particles and the effect of intermolecular forces on the probability of the impact excitation of vibrations in diatomic molecules. Experiments were carried out for measuring the time of relaxation of the vibration energy of O_2 molecules in mixtures with He, Ar, and Xe. The relaxation times measured were in the 0.2 to 4-microsecond range. The excitation probability was calculated by determining the relative effectiveness of the various atoms, M on the basis of the expression $P_{O_2M}/P_{O_2O_2}$. It was found that the Ar atom is 6 to 7 times less effective than the O_2 molecule in the 2500 to 5000°K range; at higher temperatures the effectiveness of Ar increased. The effectiveness of He was close to that of O_2, while Xe was quiet ineffective; the above ratio is about 1 in the first case and about 0.03 in the second. This behavior is attributed to the difference of the atomic masses of Ar, He, and Xe. (TTT)

771 SPECTRUM OF Er^{3+} IN $LaCl_3$. J. C. Eisenstein (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 39: 2128-33(Nov. 1, 1963).

The energy levels of the Er^{3+} ion in $LaCl_3$ were calculated by finding the eigenvalues of the matrices for the combined Coulomb, spin–orbit, and crystal-field interactions within the f^{11} configuration. For suitably chosen values of the three Slater integrals and the spin–orbit coupling constant the root-mean-square deviation between the calculated and the experimental positions of 20 terms is 140 cm^{-1}. Crystal-field parameters can be chosen which reduce the root-mean-square deviation between the calculated and the measured splittings of 72 levels to 3.84 cm^{-1}. Zeeman splitting factors in the direction parallel to the crystal axis were also calculated. The results for Er^{3+} in $LaCl_3$ were compared with those for Nd^{3+} in $LaCl_3$. (auth)

772 SPECTRUM OF Nd^{3+} IN $LaCl_3$. J. C. Eisenstein (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 39: 2134-40(Nov. 1, 1963).

The energy levels of the Nd^{3+} ion in $LaCl_3$ were calculated by finding the eigenvalues of the matrices for the combined Coulomb, spin–orbit, and crystal-field interactions within the f^3 configuration. By judicious choice of the three Slater integrals and the spin–orbit coupling constant, the standard deviation between the calculated and the experimental positions of 22 terms can be reduced to 87.5 cm^{-1}. Crystal-field parameters can be chosen that yield a standard deviation of 0.91 cm^{-1} between the calculated and the measured splittings of 31 levels in seven terms. The calculated Zeeman splitting factors in the direction parallel to the crystal axis were in good agreement with the measured values. (auth)

773 ANALYTICAL EXPRESSIONS FOR POTENTIALS OF NEUTRAL THOMAS-FERMI-DIRAC ATOMS AND FOR THE CORRESPONDING ATOMIC SCATTERING FACTORS FOR X RAYS AND ELECTRONS. R. A. Bonham and T. G. Strand (Indiana Univ., Bloomington). J. Chem. Phys., 39: 2200-4(Nov. 1, 1963).

Approximate analytical expressions for the electrostatic potentials of neutral Thomas-Fermi-Dirac atoms were obtained by fitting a sum of three exponential terms to the tabulated values by least-squares methods. The six different parameters used for each atom are expressed as functions of the atomic number. The corresponding expressions for the radial electron density, mean-square radius, diamagnetic susceptibility, atomic scattering factors for x rays and the atomic scattering factors for electrons according to the first Born approximation are given. The accuracy of the approximate expressions are discussed in relation to results obtained from the tabulated values of the electrostatic potential and from the corresponding electron density. (auth)

774 CHARGE DENSITIES IN ATOMS. Erich Steiner (Univ. of Keele, Eng.). J. Chem. Phys., 39: 2365-6(Nov. 1, 1963).

A corollary to a theorem by Kato (Commun. Pure Appl. Math., 10: 151(1957)) is derived that relates the charge density and its derivative at the nucleus of an atom. For nuclear charge Z it is $(\partial\rho/\partial r)_{r=0} = -2Z\rho(0)$. (auth)

775 TEMPERATURE DEPENDENCE OF THE Cl^{35} PURE QUADRUPOLE RESONANCE IN $NaClO_3$. W. D. Partlow and W. G. Moulton (Univ. of Alabama, University). J. Chem. Phys., 39: 2381-2(Nov. 1, 1963).

The pure quadrupole resonance of Cl^{35} in $NaClO_3$ was studied at 54 to 4.2°K. The data obtained were fitted to the Bayer-Kushida theory over three different temperature ranges: 4.2 to 54°K; 16 to 54°K; and 4.2 to 78°K. It was found that the values obtained by fitting the data to the Bayer-Kushida theory are not consistent with the calculated values of Kushida for the temperature ranges fitted. (P.C.H.)

776 Ga^{71} QUADRUPOLE INTERACTION IN α-Ga_2O_3 POWDER. Wm. J. Veigele (Martin-Marietta Corp., Denver). J. Chem. Phys., 39: 2389-90(Nov. 1, 1963).

The quadrupole coupling constant, e^2qQ/h, of Ga^{17} in α Ga_2O_3 powder was measured by observing the second-order shift of the $(+\frac{1}{2} \rightarrow -\frac{1}{2})$ nuclear transition. A value of $e^2qQ/h = 8.20$ Mc/sec was calculated from the second order shift of the resonance assuming the asymmetry parameter $\eta = 0$. The Ga^{3+} Sternheimer antishielding factor was calculated to be −14.4. (P.C.H.)

777 CALCULATION OF X-RAY AND ELECTRON INTENSITIES SCATTERED BY THE NH_3 AND H_2O MOLECULES. Claude Tavard (Faculté des Sciences, Orsay, France), Marcel Rouault, Monique Roux, and Marguerite Cornille. J. Chem. Phys., 39: 2390-1(Nov. 1, 1963).

Two methods were used to calculate the x-ray and electron scattering intensities for NH_3 and H_2O: the united atom method, and the Debye and Ehrenfest method. The two resulting intensities were compared. Differences between the two results were specially important in the inner region corresponding to values of $\sin(\frac{1}{2}\theta)/\lambda = 0.125$ au or 0.236 A^{-1}. The observed differences between the two calculations in these regions of the scattering angle were from 15 to 20% of the total intensities and could be due to the bonding effect. (P.C.H.)

778 ATOMIC SPECTROSCOPY IN OPTICS AND SPECTROSCOPY, 1959-1962. G. W. Charles (Oak Ridge National Lab., Tenn.). J. Opt. Soc. Am., 53: 1319-29 (Nov. 1963).

A review is given of papers on atomic spectroscopy

appearing in the Russian journal Optics and Spectroscopy over the period 1959 to 1962, when an English translation was made available. Subjects considered include: isotope shift and hyperfine structure; oscillator strengths; rare-earth ion spectra; excitation cross sections of spectral lines; spectral lines in plasmas; and quantum-mechanical calculations. (153 references.) (R.E.U.)

779 EFFECT OF NUCLEAR SIZE ON X-RAY FINE STRUCTURE. A. S. Meligy (Univ. of Alexandria, Egypt). Nucl. Phys., 47: 449-53(Sept. 1963).

An accurate expression for the change in the fine structure splitting due to nuclear size is given, which corrects the expression obtained by Schawlow and Townes for approximate normalization of the electron wave functions. (auth)

780 NOTE ON THE INTEGRATED INTENSITY IN THE TIME-OF-FLIGHT METHOD FOR CRYSTAL STRUCTURE INVESTIGATIONS. Bronislaw Buras (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 259-60(1963).

The formula for the integrated intensity in the time-of-flight method for neutron diffraction structure investigations of powdered crystals is derived. The kinetic theory of neutron diffraction is used, and the effects of thermal vibrations, absorption, and extinction are ignored. It is assumed that the structure factor is a slowly varying wavelength-dependent function. (C.E.S.)

781 THE ELASTIC SCATTERING OF SLOW S-ELECTRONS BY HELIUM ATOMS. V. T. Murav'ev and B. M. Yavorskii. Opt. Spectry. (USSR) (English Transl.), 15: 69-70(July 1963).

The phases and wave functions of slow S-electrons scattered by helium atoms were calculated by Kohn's method with and without corrections for exchange and without consideration of polarization. (C.E.S.)

782 INFRARED LATTICE REFLECTION SPECTRA OF LiCl, LiBr, KF, RbF, AND CsF. Marvin Hass (Naval Research Lab., Washington, D. C.). Phys. Chem. Solids, 24: 1159-64(Oct. 1963).

The infrared lattice reflection spectra of LiCl, LiBr, KF, RbF, and CsF were measured in the spectral region from 95 to 1500 cm^{-1} and were analyzed by the Kramers-Krönig method. The following fundamental dispersion frequencies were obtained: LiCl, 191 ± 2 cm^{-1}; LiBr, 159 ± 4 cm^{-1}; KF, 190 ± 2 cm^{-1}; RbF, 156 ± 2 cm^{-1}; CsF, 115(?) cm^{-1}. The effective charges and compressibilities were computed with the aid of the Szigeti relations. (auth)

783 ROTATIONAL EXCITATION OF MOLECULAR IONS BY SLOW ELECTRONS. Robert C. Stabler (RCA Defense Electronic Products, Princeton, N. J.). Phys. Rev., 131: 679-83(July 15, 1963).

The cross section for the excitation of rotation of a molecular ion by low-energy electrons was calculated using first-order perturbation theory and approximate Coulomb wave functions. For ions with vanishing electric dipole moment, quadrupole moment Q, and rotational quantum number J, the cross section is found to be 2.0×10^{-15} $cm^2(Q/ea_0^2)(1\ ev/E_i)\eta(J)$, where E_i is the incident electron energy and $\frac{1}{4} < \eta(J) < \frac{2}{3}$ for all J. The rate-of-energy loss to molecular ions arising from these inelastic collisions is found to be about 10% of the loss from elastic Coulomb collisions, independent of energy. This mechanism, thus, will result in a slight increase in the energy-transfer collision frequency under conditions where molecular ions are present. (auth)

784 NUCLEAR SPIN-LATTICE RELAXATION IN LIQUIDS. P. K. Sharma and S. K. Joshi (Univ. of Allahabad, India). Phys. Rev., 132: 1431-4(Nov. 15, 1963).

The spin-lattice relaxation in liquids was investigated on the basis of quasicrystalline models. Explicit expressions for spin-lattice relaxation time T_1 are derived for the jump-diffusion model and the stochastic model. The theory was applied to the case of water and the constants used in the calculation are derived from the experimental data on the cold-neutron scattering. The spin-lattice relaxation is found to be quite insensitive to the details of the models. (auth)

785 ION MOBILITIES IN HELIUM, NEON, AND ARGON. H. J. Oskam and V. R. Mittelstadt (Univ. of Minnesota, Minneapolis). Phys. Rev., 132: 1435-44(Nov. 15, 1963).

Measurements of the electron density as a function of time during the decay period of pulsed plasmas produced in helium, neon, and argon are reported. The values of the mobilities of positive ions in their parent gas, calculated from the rate of electron loss by ambipolar diffusion, are compared with those measured with the ion-transit-time methods. The values, consistent with data obtained with these two different measuring techniques, are $\mu_0(He^+)$ = 10.7, $\mu_0(He_2^+)$ = 16.2, $\mu_0(Ne^+)$ = 4.1, $\mu_0(Ne_2^+)$ = 6.5, $\mu_0(Ar^+)$ = 1.6, and $\mu_0(Ar_2^+)$ = 1.9 cm^2/V sec. The dependence on gas pressure of the efficiency of the cataphoretic segregation of neon impurity atoms in helium is demonstrated and explained. (auth)

786 RECOMBINATION COEFFICIENT OF MOLECULAR RARE-GAS IONS. H. J. Oskam and V. R. Mittelstadt (Univ. of Minnesota, Minneapolis). Phys. Rev., 132: 1445-54(Nov. 15, 1963).

The coefficients relating to the recombination of molecular rare-gas ions with electrons are determined from the slope of the straight part of the curve representing the reciprocal of the electron density as a function of time during the afterglow period of plasmas produced in helium, neon, argon, krypton, and xenon. The results are compared with the machine computation of Gray and Kerr. The influence on the measurements of the magnitude and duration of the plasma excitation pulse was studied. The values of the recombination coefficients obtained are $\alpha_r(He_2^+) \leq 4 \times 10^{-9}$, $\alpha_r(Ne_2^+) = (2.2 \pm 0.2) \times 10^{-7}$, $\alpha_r(Ar_2^+) = (6.7 \pm 0.5) \times 10^{-7}$, $\alpha_r(Kr_2^+) = (1.2 + 0.1) \times 10^{-6}$, and $\alpha_r(Xe_2^+) = (1.4 \pm 0.1) \times 10^{-6}$ $cm^3\ sec^{-1}$. The values were independent of gas pressure over the pressure ranges studied. The influence of the measuring technique of the collision frequency for momentum transfer of electrons with gas atoms caused an apparent pressure dependence of the measured recombination coefficient of Xe_2^+ ions. (auth)

787 ELECTRON SPIN RESONANCE OF Er^{3+} IN CaF_2. U. Ranon (Israel Atomic Energy Commission, Rehovoth) and W. Low. Phys. Rev., 132: 1609-11(Nov. 15, 1963).

Five different spectra of Er^{3+} in CaF_2 were observed. One spectrum corresponds to a field of cubic symmetry with g = 6.785 ± 0.002; and one corresponds to a field of triagonal symmetry brought about by a substitution of O^{2-} ions for F^- ions, with $g_\parallel$ = 2.206 ± 0.007, $g_\perp$ = 8.843 ± 0.01. A third spectrum, also of trigonal symmetry with $g_\parallel$ = 3.30 ± 0.01, $g_\perp$ = 8.54 ± 0.02 is thought to be caused by a substitutional OH^- ion. A spectrum of tetragonal symmetry with $g_\parallel$ = 1.746 ± 0.002 and $g_\perp$ = 9.16 ± 0.01 is believed to arise from sites of Er^{3+} ions with interstitial F^- ions in adjacent cubes. A fifth spectrum, for which the compen-

sating ion is not identified, has tetragonal symmetry, with $g_{\parallel} = 7.78 \pm 0.02$ and $g_{\perp} = 6.254 \pm 0.005$. The data permit the evaluation of the nuclear magnetic moment of Er^{167} as $\mu_N = 0.56 \pm 0.05$ nuclear magnetons. (auth)

788 DOUBLE-ELECTRON CAPTURE BY PROTONS IN H_2 GAS. Gordon W. McClure (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 132: 1636-7(Nov. 15, 1963). (TID-19114; SCDC-3300)

The cross section for capture of two electrons by protons in single collisions with H_2 molecules was redetermined in order to obtain an independent check on the several previous measurements of Fogel and coworkers. The apparatus utilizes a gas proportional counter as a detector of both the fast H^- ions resulting from double electron capture and the fast H atoms resulting from single-electron capture. The known cross section for the single-electron capture process provided a firm basis for calibration of the apparatus. It was found that the H^- production cross section reached a maximum of 1×10^{-17} cm^2/gas molecule at an incident proton energy of 20 kev in agreement with the latest Fogel results; however, the shape of the measured cross-section curve differs greatly on either side of the maximum from the Fogel curve. This discrepancy appears to be far outside the limits of experimental error. (auth)

789 EXCITED STATES OF THE F-CENTER ELECTRON. R. F. Wood (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 11: 202-4(Sept. 1, 1963).

The electronic structure of the F center in LiCl was calculated by the LCAO method in which the wave functions of the ground and excited states were expressed as linear combinations of the 2s and 2p Li orbitals on the third-nearest-neighbor ions, the 2s orbitals on the fifth-nearest-neighbor ions, and a 2p function located at the center of the vacancy. (C.E.S.)

790 ADDITIVE COLOR CENTERS IN CALCIUM FLUORIDE. W. A. Runciman, C. V. Stager, and M. H. Crozier (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 11: 204-5(Sept. 1, 1963).

Two sharp lines were observed in the absorption spectrum of additively colored crystals of synthetic CaF_2 at 4.2°K. These lines have wavelengths of 8434.1 and 8433.0 Å with corresponding wave numbers 11,853.5 and 11,855.0 cm^{-1}. They were well resolved with an optical wavelength of ~ 0.3 cm^{-1}. A model for these centers was proposed. (C.E.S.)

791 MAGNETOMORPHIC OSCILLATIONS IN THE HALL EFFECT AND MAGNETORESISTANCE IN CADMIUM. N. H. Zebouni, R. E. Hamburg, and H. J. Mackey (Louisiana State Univ., Baton Rouge). Phys. Rev. Letters, 11: 260-4(Sept. 15, 1963).

Large-amplitude oscillations periodic in the magnetic field were found in the Hall resistivity of cadmium single crystals at liquid helium temperatures. Oscillations of the same period and comparable amplitude were observed also in the transverse magnetoresistivity. The oscillations differ in phase by about 55° or 130 gauss. The crystal size, orientation, and temperature dependence of the oscillations were discussed. (C.E.S.)

792 SPIN DENSITY IN COBALT. R. J. Weiss (Imperial Coll. of Science and Tech., London). Phys. Rev. Letters, 11: 264-5(Sept. 15, 1963).

The temperature dependence of the spin density, the variation of the difference in spin-up and spin-down charge density with temperature, and the occupation of the doubly degenerate and triply degenerate orbitals of f-c-c cobalt were determined from previous data on the magnetic form factor of cobalt. The fraction of the spin density in the doubly degenerate orbitals was also presented for b-c-c Fe and f-c-c Ni. (C.E.S.)

793 ZERO-PHONON TRANSITIONS OF COLOR CENTERS IN ALKALI HALIDES. D. B. Fitchen, R. H. Silsbee, T. A. Fulton, and E. L. Wolf (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 11: 275-7(Sept. 15, 1963). (TID-19323)

Features of the optical absorption spectra of point defects in solids that are analogous to those of the Mössbauer spectra in solids are considered, and the observation of the corresponding zero-phonon lines associated with some of the F-aggregate color-center bands in LiF, NaF, NaCl, KCl, and KBr are reported. (C.E.S.)

794 VARIATIONAL THEORY OF THREE-BODY ELECTRON ION RECOMBINATION RATES. B. Makin (Univ. of Southampton, Eng.) and J. C. Keck. Phys. Rev. Letters, 11: 281-3(Sept. 15, 1963).

The rate of three-body electron-ion recombination is calculated from a classical variational theory. The motion of the three bodies is described by a representative point in an 18-dimensional phase space. (C.E.S.)

795 UNUSUAL INFRARED FLUORESCENCE IN $PrCl_3(Nd^{3+})$ CRYSTALS. F. Varsanyi (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 11: 314-15(Oct. 1, 1963).

A very intense and sharp fluorescence line was observed at 2.54 μ when anhydrous praseodymium chloride containing a few tenths of a percent Nd^{3+} was illuminated with blackbody radiation. Excitation was so efficient that a small tungsten filament lamp operated at one-tenth or less power with the filament just noticeably glowing allows detailed studies of the line at very high spectral resolution. The linewidth is less than 0.2 of a wave number. The decay time is in the order of 50 msec. The excitation radiation is absorbed by praseodymium ions while the emission is identified as fluorescence of Nd^{3+}. (C.E.S.)

796 HYPERFINE SEPARATION OF GROUND-STATE ATOMIC HYDROGEN. Stuart B. Crampton, Daniel Kleppner, and Norman F. Ramsey (Harvard Univ., Cambridge, Mass.). Phys. Rev. Letters, 11: 338-40(Oct. 1, 1963).

The hyperfine separation of hydrogen in its ground state was determined by means of the hydrogen maser. Two masers were operated simultaneously for purposes of tuning, checking internal consistency, and measuring the wall shift. A secondary frequency standard was also used. Corrections were made for the magnetic field offset, second-order Doppler shift, and the wall shift. (C.E.S.)

797 ON THE FLUORESCENCE OF SYNTHETIC LiF CRYSTALS. P. Goerlich, H. Karras, and G. Koetitz. Phys. Status Solidi, 3: 1803-18(1963).

The relative spectral distribution of the fluorescence of both untreated and radiation-colored LiF crystals were investigated at monochromatic excitation in the range from 253 to 635 nm. Fluorescence was shown to be slightly influenced by the growing procedure of the crystals (air or vacuum-grown) and the type of coloration (x rays or deuterons), but it was not until longer exciting wavelengths were used that this influence became more distinct. Fluorescences with peaks at 530 and 670 nm emitted at R_1, R_2, or M band excitation could be verified. In addition, at F band excitation an emission was observed likewise at 530 and 670 nm, which could also be stimulated, individually

or commonly, by light of the R_1, R_2, or M bands. This may be interpreted in terms of an energy transfer process from the absorbing to the emitting centers. (auth)

798 BIREFRINGENCE INDUCED BY LIGHT IN POTASSIUM CHLORIDE CRYSTALS COLORED BY IONIZING RADIATION. J. Z. Damm and K. Łukaszewicz (Inst. of Structural Research, Polish Academy of Sciences, Wroclaw). Phys. Status Solidi, 3: 1857-64(1963).

An anisotropic effect was observed in some potassium chloride crystals colored by ionizing radiation. The colored samples exhibited birefringence after illumination with ordinary or polarized light. By using suitable illumination conditions it was possible to obtain both uni- and biaxial crystals with optical directions parallel to the cube edges, and possessing either negative or positive optical signs. It was found that only light of wavelength between 625 and 750 nm is effective in producing the optical anisotropy and that the light undergoing double refraction lies in the same range of wavelengths. Some properties of the defects responsible for the birefringence and a possible mechanism of the effect are discussed. (auth)

799 ON THE EXCITATION OF THE SPONTANEOUS FLUORESCENCE OF SYNTHETIC CaF_2/U^{3+} CRYSTALS. P. Goerlich, H. Karras, and G. Koetitz. Phys. Status Solidi, 3: 1935-40(1963).

Recent published experimental results relating to magnetic resonance, absorption, spontaneous fluorescence, and induced emission, on uranium-doped CaF_2 crystals are discussed. Experiments are reported, which yielded a dependence of the spectral intensity distribution of the spontaneous fluorescence on the wavelength of the exciting light. Two distinct types of emission spectra were established. (auth)

800 CORRELATION EFFECTS IN ATOMS. Hugh Padraic Kelly. Thesis, Berkeley, Calif., Univ. of California, 1963. 66p.

The applicability of many-body perturbation theory in calculating electron correlations in atoms has been investigated. It was found that, in order for results to agree well with experiment, certain classes of diagrams, representing terms of the perturbation series, must be included to many orders. The higher-order diagrams were found to be more important in calculating correlations among the outer electrons than among inner electrons. Methods for summing various classes of these diagrams were found. The total correlation energy in Be was calculated by perturbation theory, with the use of an IBM 7090 computer, to be -2.48 ± 0.11 ev. The value obtained from experiment is -2.59 ev. The calculated correlation energies for the different electronic shells were found to be -1.19 ev among 2s electrons, -1.15 ev among 1s electrons, and -0.135 ev between the 1s and 2s shells. (Dissertation Abstr.)

801 ELECTRON IMPACT STUDY OF NITROGEN AND THE GROUND STATE MOMENTUM FUNCTION OF THE HYDROGEN MOLECULE ION. Frederic Mohr Glaser. Thesis, Columbus, Ohio, Ohio State Univ., 1963. 112p.

The electron impact spectrum of N was reinvestigated to try to resolve broad peaks and to correlate them with the bands observed in the vacuum ultraviolet spectrum. The most intense transition in the N impact spectrum occurs at 12.93 ± 0.03 v. The position of this peak was used as the reference peak to establish the positions of the other peaks observed in the N spectrum. Nineteen peaks were resolved, and 12 were correlated with bands observed in the vacuum ultraviolet spectrum. The most intense transition was assigned to the excitation to the $\rho'\ ^1\Sigma_u^+$ state from the ground state of N, $x\ ^1\Sigma_g^+$. The peak at 13.22 v was correlated with the $x\ ^1\Sigma_g^+(v'' = 0) \rightarrow \rho'\ ^1\Sigma_u^+(v' = 1)$ transition. The generalized oscillator strengths of the 3 most prominent peaks in the N spectrum were also determined. The oscillator strength of the 12.93 volt peak was determined to be 0.937 amu. The exact momentum function for the ground state of the H molecule ion was obtained by transforming the solution of Schroedinger's equation. It was concluded that linear variation functions used to approximate the momentum functions for molecules must contain oscillating terms inasmuch as the exact ground state momentum function for H_2^+ was found to oscillate. (M.P.G.)

Cosmic Radiation

802 (AFCRL-63-214) NEUTRON MEASUREMENTS OUTSIDE THE EARTH'S ATMOSPHERE. Final Report. L. Witten and J. P. Martin (Martin-Marietta Corp. Aerospace Div., Baltimore). Jan. 1963. Contract AF19(604)-7244. 27p. (AD-297511)

A pair of neutron counting systems carried on a ballistic flight path detected the fast neutron flux and the slow neutron density. Measurements of albedo neutrons were made between 480 and 1000 km altitude. The pod entered the trapped radiation belt in the vicinity of 1000 km altitude and 27° North Geomagnetic latitude. The albedo neutron results from both systems are compared with the flux calculations of Hess, Canfield and Lingenfelter; the flux data are compared with the work of Hess and Starnes; and the density data are compared with the measurements of Reidy, Haymes, and Korff. A low altitude increase in the density count rate suggests that some low energy trapped protons are found beginning at a lower altitude than the higher energy trapped protons. A comparison of dose rates in tissue, calculated from these neutron data and from other proton data for various amounts of shielding, shows that the dosage from neutrons becomes the main hazard inside a shielded vehicle as the shielding thickness increases. (auth)

803 CHARACTERISTICS OF DAILY VARIATION OF COSMIC-RAY NEUTRON INTENSITY RECORDED DURING I.G.Y. R. P. Kane (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 29: 801-25 (Aug. 16, 1963).

Neutron-monitor data for similar latitudes and longitudes were combined, and the average daily variations for cosmic-ray neutrons for middle latitudes and equatorial regions were studied on a day-to-day basis during I.G.Y. A comparison with several solar and terrestrial phenomena reveals no one-to-one relation with any element but yields a general statistical indication that high amplitudes of the first harmonic of daily variation may follow Type IV solar bursts and precede cosmic-ray and geomagnetic storms. High amplitudes of the first harmonic occur often on a world-wide basis (though sometimes only in restricted longitudes), show a (29 ± 1) day recurrence tendency with a likelihood of a minor 8 day recurrence tendency, and have hours of maxima mostly in the afternoon though sometimes at midnight and early morning hours also. Several other details about first and second harmonics are discussed. (auth)

804 INTERACTIONS OF COSMIC-RAY MUONS IN A THICK Pb ABSORBER. S. H. Neddermeyer and S. B. Curtis (Univ. of Washington, Seattle). Phys. Rev., 131: 835-47(July 15, 1963).

A cloud-chamber study of the momentum losses of the

sea-level cosmic-ray particles is presented, in the range 1 to 20 Bev/c, in a 317-g/cm^2 Pb target, by measurement of curvature in an 11,000-G magnetic field before and after traversal of the target. The incident particles are filtered by 28-in. Pb, corresponding to a normal momentum loss of about 1 Bev/c. One set of data is taken with simple coincidences to give essentially a random sample of the incident particles, and a second set with a 3 to 1 fold coincidence requiring large pulses, equivalent to ~10 minimum ionization particles, in one or both of two proportional counters located below and in the middle of the absorber. The experiment is not highly precise; nevertheless, the first part, which is presumed to be dominated by the normal probable collision energy loss, gives a reasonably good test of the error analysis, and the second part shows larger fluctuations which are shown to be at least in qualitative agreement with normal electromagnetic processes of muons. The energy distribution of showers observed in the lower chamber in the second sample is also in qualitative agreement with expectations for muons. The positive excess of the selected particles, defined by $\eta = (N_+ - N_-)/(N_+ + N_-)$, is 0.10 ± 0.04 for the entire experiment (exclusive of the visible shower events) compared with 0.11 ± 0.02, an average for several other workers. The primaries of the shower events, however, give $\eta = 0.49 \pm 0.12$. It is shown that this result cannot reasonably be attributed to contamination by protons, and it is equally difficult to attribute the effect to errors. (auth)

805 TIME DEPENDENCE OF THE DECAY ENERGY SPECTRUM FOR STOPPED COSMIC-RAY PARTICLES AT SEA LEVEL. Elihu Boldt, Paul Stoler, and Costa Tsipis (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 132: 1803-9(Nov. 15, 1963).

Within the indicated standard statistical uncertainties, the mean life (τ) for particles of the sea-level cosmic-ray μ-meson beam, stopped in carbon, is independent of the decay energy classification (E in Mev). $\tau(29 > E > 11)/\tau(50 > E > 29) = 1.01 \pm 0.03$, $\tau(66 > E > 43)/\tau(E > 26) = 1.07 \pm 0.05$, $\tau(E > 26) = (2.109 \pm 0.032)$ μsec. (auth)

806 AN INVESTIGATION OF INTERACTION SYSTEMATICS IN COSMIC RAY EVENTS OBTAINED IN THE INTERNATIONAL COOPERATIVE EMULSION FLIGHT EXPERIMENT. Clifford Leonard Deney, Jr. Thesis, Baton Rouge, La., Louisiana State Univ., 1963. 86p.

The analysis of 4 characteristics of the interactions of mesons having an average energy greater than 100 Bev with emulsion nuclei is described. Experimental details are presented. A new method of analysis to obtain the quantity K_{ch}, the fraction of the incident meson energy radiated as charged-particle total energy in a meson-emulsion interaction, is described and is used to obtain the result $K_{ch} = 0.35 \pm 0.05$. The dependence of the mean multiplicity of produced charged mesons on the energy of the incident particle (meson or nucleon) was determined. The mean charged-particle multiplicity of 89 meson-emulsion interactions of average energy 470 Bev was found to be 9.7 ± 0.7. The mean charged-particle multiplicity of 13 nucleon-emulsion collisions at an average energy of 3100 Bev was found to be 11 ± 1. This result, in combination with results at other energies, indicates that the mean multiplicity—energy relationship is not in disagreement with the predictions of the statistical theories. A discussion of the shape of the multiplicity frequency distribution at constant incident energy is given. For the 89 meson-emulsion events considered, it was found that the number of interactions having an even number of outgoing charged particles exceeded the number of interactions having an odd number of outgoing charged particles by 60%. On the basis of a χ^2 test, this disparity is significant. An explanation is attempted considering nuclear cascading and a possible excess of protons near the nuclear surface. From a simple calculation, the proton density at the surface of the typical emulsion nucleus would be considerably higher than is expected from extensive experiments at lower energies. A discussion is given of a means of calculating the effective target mass involved in very high energy collisions using only the quantities usually determined in cosmic-ray experiments, and the use of the model is illustrated. (Dissertation Abstr.)

Criticality Studies

807 (LAMS-2955) CRITICAL DIMENSIONS OF URANIUM(93.5)–GRAPHITE–WATER SPHERES, CYLINDERS, AND SLABS. William R. Stratton (Los Alamos Scientific Lab., N. Mex.). May 1962. Contract W-7405-eng-36. 36p.

A parametric study of the critical dimensions of U(93.5)–graphite–water spheres, slabs, and cylinders is presented. The data were obtained by application of the LASL DSN code and include five different loadings of uranium in graphite; the range of moderation as caused by water is complete. Both unreflected and water-reflected systems are considered. (auth)

808 (NP-13092) SUBCRITICAL ASSEMBLIES. A Compilation of References. W. Maurice Pritchard (Old Dominion Coll., Norfolk, Va.). Aug. 1963. 48p.

A survey was made of the literature pertaining to exponential experiments and facilities. As a result of this survey, a compilation is given of references abstracted in Nuclear Science Abstracts between January 1951 and May 1963. The 219 references are arranged by subjects in chronological order under each subject heading. An author and a report number availability index is also provided. (auth)

809 HYDRO CRITICAL ASSEMBLY (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1046)

This package contains 5 drawings. Hydro is a cylindrical, water-reflected, water-cooled enriched-uranium (about 36 kg) critical assembly. It is used as a neutron source in experiments requiring power levels up to 3 kw. These experiments include exponential column and fission spectra measurements and radiochemistry calibrations. Ordinary water reflector may be added to the sides of the core by remote control. A polyethylene cylinder is positioned at the bottom of the core to adjust the reactivity of the system. The machine is portable and can be installed in an outdoor facility if there is a shielded vault that can be used for storage after operation. (F.S.)

Direct Energy Conversion

810 (63SD862) OUT-OF-CORE NUCLEAR THERMIONIC STUDY. Quarterly Report No. 1, July 1–September 30, 1963. (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Oct. 30, 1963. Contract NASw-741. 112p.

Results of analysis and design studies accomplished on one-loop and two-loop thermionic radiator-generator systems and the two-loop thermionic heat exchanger-generator are described. An extensive compilation of measured thermionic converter emission data at emitter

temperatures of 1100, 1200, 1300, and 1400°C was prepared for a planar converter consisting of a molybdenum emitter and nickel collector with a 5-mil gap. These data were experimentally optimized with respect to cesium and collector temperatures, and were used to calculate parametric efficiencies and actual power densities for the cylindrical thermionic radiator and heat exchanger converter designs. An overall evaluation of the design and fabrication problems, system weight and performance, reliability, operational factors and growth potential, resulted in the conclusion that the heat exchanger location for mounting thermionic converters offers considerably more promise than the radiator location. (N.W.R.)

811 (AD-289355) EXPLORATORY STATIC ENERGY CONVERSION STUDY—MULTILAYER THERMIONICS. First Quarterly Progress Report, July 1—September 30, 1962. V. A. Russell, W. Tantraporn, and W. J. van der Grinten (General Electric Co. Advanced Semiconductor Lab., Syracuse, N. Y.). Contract AF33(657)-9204. 41p.

A new static heat-to-electricity conversion principle is described which attempts to duplicate in the solid state at a lower temperature the high impedance performance of a vacuum thermionic converter. The basic arrangement is a multilayer structure of thin film semiconductors or insulators perpendicular to the heat flow, separated by thin layers of metals. The optimization of the transverse mean free path of the charge carriers, film thickness, contact potentials, and other parameters is discussed. An outline of the exploratory experimental study of this new concept and some practical details on film production and measurements are given. (auth)

812 (AD-293420) INVESTIGATION OF NON-EQUILIBRIUM IONIZATION FOR MHD ENERGY CONVERSION. Supplement to Quarterly Report No. 3, September 15,—December 15, 1962. George W. Sutton (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Contract AF33(657)-8298. 29p.

Power densities as a function of magnetic field were calculated for Li, K, Na, Cs, and Rb vapors. A potassium vapor blowdown experiment was devised to demonstrate magnetically induced non-equilibrium ionization in alkali metal vapors. The design and development of the apparatus for this experiment and for an Ar—Cs continuous flow magnetohydrodynamic experiment are reported. For the latter experiment, plasma electrical conductivity and power density vs magnetic field, magnetic field and electron temperature effects on plasma electrical conductivity, and the effects and optimization of seed concentration were calculated. (D.C.W.)

813 (AD-298666) FIRST QUARTERLY REPORT FOR ADDITIVE CONVERTER STUDIES. Report No. 20-63. A. L. Hyland (Thermo Electron Engineering Corp., Waltham, Mass.). Mar. 1963. Contract AF33(657)-10130. 14p.

The reasons for the expectation of better performance of the thermionic converter, due to the addition of electronegative atoms, are given. The designs used in the experimental verification of these expectations are shown. Background work and plans for the future are discussed. (auth)

814 (AD-420837) KRYPTON-FILLED THERMIONIC CONVERTER. Quarterly Technical Progress Report No. 3, July 1, 1963—September 30, 1963. (Union Carbide Corp. Parma Research Center, Ohio). Oct. 1963. Contract AF33(657)-10131. 26p.

Exploratory research work on irradiated inert gas-filled thermionic diodes is presented. Tubes containing xenon and krypton were tested in the radiation field of a 5-Mw swimming pool type reactor, and cathode current outputs in the range of 1 amp/cm^2 were obtained. Early breakdown effects were observed in irradiated xenon-filled diodes at voltages as low as 0.3 volt, and this effect appears to be dependent on cathode-anode spacing and pressure. At radiation dosages between 10^8—10^9 rads/hr, the current output of inert gas-filled thermionic diodes increases approximately linearly with radiation dosage. Experiments to increase output in the power quadrant of the thermionic diode, used as a converter, by the design of low anode work function tubes are also described. (auth)

815 (AI-9050) CLAD CARBIDE NUCLEAR FUEL THERMIONIC POWER MODULES. Second Quarterly Report. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1963. Contract AF33(657)-10876. 37p.

A clad carbide emitter, thermionic power module, which simulates nuclear reactor installation, design, and performance is evaluated. The module is an assembly of two series-connected converters with a single common cesium reservoir. The program goal is 500 hr cummulative operation at a power density of 7 watts/cm^2 and an efficiency of 12%. Progress made includes: minor design refinement of several components, completion of fabrication of all module components with the single exception of insulated collector structure, thermal stability tests of critical brazes and welds, completion of the module performance evaluation test setup, development and evaluation of fueled emitter fabrication techniques, and postoperation metallurgical examination of fueled planar emitter from fueled converter test. (auth)

816 (NP-13257) LO-TEMP THERMIONIC PLASMA STUDY. Final Report. (Ford Instrument Co., Long Island City, N. Y.). Jan. 31, 1963. Contract Nonr 3416(00). 120p.

Electron temperature, electron concentration and space potential in the plasma region of low temperature thermionic converters were measured by a pulsed Langmuir probe technique. The spatial distributions of these parameters, in parallel plate geometry, were measured with the aid of movable probes within these operating converters. The experimental values are shown to be consistant with reasonable physical models. Spectroscopic measurements were made in both the visible and infrared regions, and the validity and applicability of the results are discussed. Results obtained from converters, in which small amounts of oxygen were present in the discharge region, are explored. The effects of cesium and patch effects on the surface characteristics of impregnated tungsten emitters are discussed on the basis of a theoretical analysis and experimental results with numerous test cells. (auth)

817 (NP-13265) LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT. Interim Scientific Report No. 6, June 15—September 15, 1963. E. V. Somers, R. L. Hundstad, R. E. Voshall, J. G. DeSteese,, F. A. Holmes, and B. W. Swanson (Westinghouse Electric Corp., Pittsburgh). Contract AF33(657)-8311. 59p.

The effect of wall friction and heat transfer on magnetohydrodynamic (MHD) devices was examined, and the key parameters affecting the efficiency are given. A Reynold's analogy was used to study the effect of heat transfer. Photoionization was proposed as a means of ionizing the gas in the MHD duct. An experiment was devised to measure the electrical conductivity of a Cs vapor

that is ionized by ultra-violet radiation from commercial mercury lamps. Using the ultra-violet radiation from two H-4 100 watt mercury lamps, an electrical conductivity of approximately 10^{-2} mho/m was measured for a Cs pressure of 10^{-2} torr. Calculations indicate that ambipolar diffusion is the dominating electron-ion pair loss mechanism. Therefore, the measured electrical conductivity may be larger than the measured value if this loss mechanism is retarded. (auth)

818 (NP-13266) THERMOELECTRIC MATERIALS. Final Report. Merton H. Brooks, ed. (Titanium Alloy Mfg. Div., National Lead Co., Niagara Falls, N. Y.). Jan. 31, 1963. Contract No. NObs-78326. 82p.

Three hundred twenty-three oxide, silicate, and metal hydride combinations were prepared and fabricated into test specimens by a variety of forming and firing techniques. Of these combinations, 309 were examined electrically for Seebeck effect and resistivity from 600 to 1200°C; the remaining few failed in test. Titanium dioxide plus 2.0 mole % Nb_2O_5 exhibited a Seebeck coefficient of -400 μv/°C and resistivity of 0.1 ohm-cm over the entire temperature range of test. Barium titanate plus 0.5 mol/% Nb_2O_5 had a Seebeck coefficient of -1700 μv/°C at 750°C that increased in magnitude to -3000 μv/°C at 1225°C; the resistivity of this composition is unknown but is greater than 5 ohm-cm. No p-type electronic semiconductor with consistent carrier type over the entire temperature range of test was developed. Positive Seebeck coefficients of considerable magnitude were developed in ionic conductors; ZrO_2-7 mol/% Y_2O_3 solid solution plus 10 mol/% Nb_2O_5 exhibited a Seebeck coefficient of +1000 μv/°C at 800°C that rose to +1600 μv/°C at 1100°C. The electrical resistivity of this composition was also greater than 5 ohm-cm. In general, most oxide semiconductors examined were found to be ionic conductors; Li_2TiO_3 was the example of such a material. None of the compositions tested gave indication of truly efficient conversion of heat to electricity; the TiO_2 plus 2.0 mol/% Nb_2O_5 had an approximate figure of merit of 7.0×10^{-5}/°C. (auth)

819 (NP-13277) DIRECT ENERGY CONVERSION LITERATURE ABSTRACTS. (Naval Research Lab., Washington, D. C.). July 1963. 178p.

References and abstracts (1076) to U. S. and foreign unclassified literature on thermoelectricity, thermionic emission, photoelectric processes, magnetohydrodynamics, electrochemical processes, energy storage, and energy sources are compiled. Availability of the documents is indicated, and an author index is included. (D.C.W.)

820 (PWA-2275) LIQUID METAL-HEATED SPACE RADIATOR-MOUNTED THERMIONIC GENERATOR. Quarterly Report No. 1, July 1–September 30, 1963. F. C. Harter (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract AF33(657)-11320. 57p. (AD-422200)

The design of the thermionic converter to be evaluated was completed. The converter incorporates a tantalum-10% tungsten alloy liquid metal containment tube insulated by BeO from a tungsten-25% rhenium emitter. A nickel collector with an interelectrode space of 8 mils was selected. The predicted performance of this converter indicates a power output of 4.7 w/cm^2 with an efficiency of 12% when the emitter temperature is 1500°C. A bifilar tungsten filament was selected for use as a heater in this program based on a study contained in this report. (auth)

821 (RADC-TDR-62-464(Vol.3)) INVESTIGATION OF MHD POWER GENERATION. VOLUME III. INTEGRATION WITH CROSSED-FIELD AND LINEAR BEAM MICROWAVE DEVICES. G. E. Pokorny and A. J. Prommer (Litton Electron Tube Corp., San Carlos, Calif.). July 9, 1962. For Pratt and Whitney Aircraft, Hartford, Conn.). Contract AF30(602)-2487. 61p. (AD-297879)

The results of a study program investigating super power microwave generation in connection with a MHD generator is summarized. The results show that a MHD power source is compatible with present day microwave generators, and that a system combining these two devices is technically and economically feasible and constitutes a very attractive package for super power microwave generation. The project was divided into two phases. The first phase was concerned with establishing the basic feasibility of such a system and an evaluation of the relative merits of different super power microwave generation schemes for this specific application. The second phase was a detailed study of specific klystron designs and their compatibility with the features peculiar to a MHD generator. (auth)

822 PHYSICAL FUNDAMENTALS OF THERMIONIC CONVERTERS, AND SURVEY ON THEIR TECHNICAL APPLICATION. J. Bohdansky and R. Langpape (Brown, Boveri & Cie AG, Mannheim, Ger.). Kerntechnik, 5: 361-5(Sept. 1963). (In German)

The possibilities of directly producing electrical energy by thermionic emission are shown. Between both the discussed types of diodes, cesium and Noble-gas, the cesium diode now seems to be further developed and also longer lasting. Electrically heated diodes were already operated for several thousand hours with sufficient efficiency. Nevertheless, these elements are not sufficiently qualified for technical use on account of the small distance of the electrodes. Ways for eliminating these difficulties are demonstrated. The so-called cesiumfluoridediode is discussed. Several problems are still to be solved. Nevertheless, the thermionic element seems to become an important power generator for special use. The employment of thermionic elements for terrestrial purposes seems to be possible in further future, too. At this time, its employment will be rather a financial problem than a technical one. (auth)

823 THE NUCLEAR CESIUM CELL. H. Neu (Euratom, Ispra, Italy). Kerntechnik, 5: 365-72(Sept. 1963). (In German)

The nuclear cesium cell is a cesium-vapor filled energy-converter for direct conversion of nuclear heat to electric energy by thermionic emission of electrons. There are presented some general lines for design and construction of cells and the selection of useful materials. A short review about in-pile tests in the USA and Europe is given. A critical discussion of the results as well as the development goals is followed by some remarks on the application of nuclear cesium cells in a thermionic reactor for space flight and for commercial electric power production. (auth)

824 NOBLE GAS FILLED THERMIONIC ENERGY CONVERTER. W. Bloss (Technische Hochschule, Stuttgart). Kerntechnik, 5: 372-6(Sept. 1963). (In German)

The different methods of ion generation in noble gases for electron space charge compensation in thermionic diodes and in thermionic converters with an auxiliary electrode are described. Values of the operating temperature, plasma resistance, and efficiency of energy conversion for

the different devices are given. The optimum operating conditions, the feasibility of a-c generation, and the fields of practical application are discussed. (auth)

825 DIRECT CONVERSION OF KINETIC ENERGY OF FISSION PRODUCTS INTO ELECTRIC ENERGY. K. Schretzmann (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 5: 377-81(Sept. 1963). (In German)

The nuclear fission energy arising in the form of kinetic energy of the fission products can be partially converted directly into electric energy in devices like diodes or triodes. Up to now in the course of experiments, extremely low efficiencies were attained. The design of a reactor where all the fuel elements consist of diodes or triodes is very difficult. Concerning single cases of application, diodes or triodes with emitters of transplutonium elements may achieve some importance. (auth)

826 RECENT DEVELOPMENTS OF MHD-POWER GENERATORS. J. Euler (Varta AG, Frankfurt am Main). Kerntechnik, 5: 382-4(Sept. 1963). (In German)

Braking channels for the reentry of space vehicles into atmospheres, material problems when using ceramics, bundles of water-cooled pipes acting as walls of MHD channels, and generation of a-c by synchronous induction are discussed. (auth)

827 PRODUCTION OF ELECTRIC ENERGY BY MEANS OF NUCLEAR BATTERIES. J. Euler and A. Scharmann (Universität, Giessen, Ger. and Varta AG, Frankfurt am Main). Kerntechnik, 5: 385-7(Sept. 1963). (In German)

The methods of electrical energy production in nuclear batteries are described. Some uses are discussed. Thermoelectric, thermionic, and photoelectric nuclear batteries are described. (R.E.U.)

828 PROSPECTS FOR THE NUCLEAR REACTOR—MHD CYCLE. R. A. Coombe (Staffordshire Coll. of Tech., Eng.). Nucl. Eng., 8: 405-8(Nov. 1963).

Some advantages, principles, and configurations of magnetohydrodynamic (MHD) generators are reviewed, and the possibility of using an MHD generator with a conventional nuclear power generation system is considered. Current work on the reactor-MHD system is summarized. (D.C.W.)

829 SAXTON TESTS LEAD TOWARD BETTER WATER REACTORS. Donald R. Rees (Saxton Nuclear Experimental Corp., Saxton, Penna.) and Edward U. Powell. Nucleonics, 21: No. 11, 72-7(Nov. 1963).

The experimental program of the Saxton reactor, functioning as a closed-cycle water-reactor test facility, is described. A description of the reactor and physical plant is given. (R.E.U.)

830 CYCLIC COMBUSTION DRIVEN SHOCKS IN A COMPRESSIBLE VORTEX AS A SOURCE OF MHD POWER. J. M. Jenkins and J. Swithenbank (Univ. of Sheffield, Eng.). 9p. (CONF-24-20)

From 4th Symposium [on] Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., Apr. 1963.

Theory and experimental data are presented on the properties of cyclic, combustion-driven shocks in a compressible vortex. In this system, part of the chemical energy is converted directly into kinetic energy. Because the temperatures encountered in these combustions approach those obtained in detonations, it is suggested that the cyclic-combustion system might be suitable for the production of magnetohydrodynamic power. The experimental data presented are based on observations of rocket motor characteristics. Effects of instabilities are discussed. (T.F.H.)

Elementary Particles and Radiations

831 (AD-420626) A QUANTUM THEORY OF ELEMENTARY PARTICLES. H. C. Corben (Space Technology Labs., Inc., Redondo Beach, Calif.). Aug. 1963. Contract Nonr-3769(00). 38p.

The quantum numbers of strangeness S, baryon number B, and isospin I are found to be natural consequences of the generalized field theory of a spinning particle developed previously, the theory requiring that $S + 2I + 2J$ is even, as observed. The generalized Dirac equation for fermions leads to the correct values of B, S, I_3 and J, and approximately the correct masses for the states n, p, Ξ^0, Ξ^-, N_{13}^{**}, N_{13}^{*0}, the lowest known states of $I = \frac{1}{2}$, $J = \frac{1}{2}$ or $\frac{3}{2}$. The generalized Dirac equation for bosons similarly describes these quantities for the K and K* mesons. The generalized Kemmer equation for fermions yields the correct values of B, S, I_3, J and the masses for the Λ^0, Y_0^* and Y_{03}^* if the spin of the Y_0^* is $\frac{1}{2}$, and the generalized Kemmer equation for bosons similarly describes a number of the mesonic states with $S = 0$. The only arbitrariness in the theory lies in the choice of two mass parameters for each equation and in the choice of which combination of two independently conserved currents allowed by each equation is identified with the electric current. The theory satisfies a correspondence principle with the classical equations of motion of a spinning particle and yields a prescription for describing states of higher quantum numbers. It then correctly describes the spin and mass of the N_{15}^* state, predicts the spin of the Y_0^{**} state as $\frac{5}{2}$, and describes other states, the properties of which have not yet been investigated. (auth)

832 (AD-420627) GENERALIZED FIELD THEORY. H. C. Corben (Space Technology Labs., Inc., Redondo Beach, Calif.). Sept. 1963. Contract Nonr-3769(00). 15p. (8665-6004-RU-000)

An examination of the assumptions of relativistic quantum field theory shows that one of them is unnecessary. Its omission improves the structure of basic theory and leads to a description of isotopic spin, strangeness, and other properties of some of the elementary particles. (auth)

833 (AERE-Bib-142) NUCLEON-DEUTERON SCATTERING AND INTERACTIONS. A Bibliography 1951 to 1962. H. A. Stoddart (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1963. 13p.

References (136) to papers appearing in NSA and Science Abstracts during 1951 through 1962 are listed alphabetically by first author. A serial index to reports is included. (D.C.W.)

834 (AFOSR-2326) STRONG INTERACTIONS SYMMETRIES AND RELATIONS BETWEEN POLARIZATIONS FOR $\bar{p}p \rightarrow \bar{Y}Y$. Technical Note No. 3. Eduardo de Rafael (Paris. Universite, Orsay. Laboratoire Joliot-Curie De Physique Nucleaire). Jan. 15, 1962. Contract AF61(052)-474. 32p. (AD-293163)

The consequences of different symmetry groups for strong interactions are studied in terms of reactions between polarizations. Some experimental tests concerning antihyperon-hyperon production by means of p-N and p-d annihilations are proposed. (auth)

835 (AFOSR-3102) ELASTIC SCATTERING OF NEGATIVE PIONS AT 16 Bev/c. Scientific Note No. 5. G. Czapek, G. Kellner, G. Otter, and H. Zwintz (Vienna. Universitat. Institut fur Theoretische Physik). June 15, 1962. Contract 61(052)-433. 12p.

The total and elastic cross sections for 16-Bev/c meson (π^-) scattering on protons were determined to be 26.8 ± 1 and 4.2 ± 0.5 mb, respectively. The differential elastic cross section agreed well with an optical model (imaginary potential or grey disk). The existence of secondary maxima in the differential cross section was found to depend only on the slope of the decrease of the potential. (D.C.W.)

836 (BNL-5569) POSSIBLE MECHANISM FOR THE P-WAVE Kπ RESONANCE. Mirza A. Baqi Bég (Brookhaven National Lab., Upton, N. Y.). July 12, 1961. Contract [AT(30-2)-Gen-16]. 7p.

A procedure for generating the P-wave K-π resonance in terms of the scalar K' meson is presented. The assumption that the fundamental K-π interaction is mediated by the K' is shown to lead to a dynamical P-wave resonance with isobaric spin ½. The observed isobaric spin splitting in the K-π system can also be satisfactorily explained. (D.C.W.)

837 (JINR-D-1345) ON THE DIFFERENCE BETWEEN MUON AND ELECTRON MASSES (ON TWO TYPES OF DIRAC FIELDS). M. A. Markov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 17p.

Starting from the Konopinski-Mahmoud hypothesis, the term of the weak interaction through symmetrical neutral currents can be written $-G(\bar{\psi}_e \gamma_\rho \psi_e \bar{\psi}_e \gamma_\rho \psi_e - \bar{\psi}_\mu \gamma_\rho \psi_\mu \bar{\psi}_\mu \gamma_\rho \psi_\mu)$. This interaction yields contributions, equal in quantity, but opposite in sign to the muon and electron bare masses. The idea of two types of Dirac fields (in particular, electron and muon ones) conjugate in the sense of the generalized Konopinski-Mahmoud hypothesis (e^-, μ^+ – particles, e^+, μ^--antiparticles, Ξ^-, p^+ particles, etc.) is more conveniently presented and interpreted with the aid of the second order equation for four-component spinors. It is equivalent to the two Dirac equations (ip + m) $\psi_I = 0$ and (ip – m) $\psi_{II} = 0$, the field quanta of which are automatically connected by the Konopinski-Mahmoud hypothesis. The quanta of the conjugate fields ψ_I and ψ_{II} possess equal bare masses. (auth)

838 (JINR-P-1263) RASSEYANIE ELEKTRONA NA ELEKTRONE I PROVERKA ELEMENTARNOSTI FOTONA. (Electron-Electron Scattering and a Check of Photon Elementarity). Nguyen Van-Hieu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 7p.

Scattering of high energy electrons by electrons is treated to determine whether a photon is elementary. If a photon is described by a Regge pole, then the matrix element of the process under consideration depends on two invariant amplitudes. However, a determination of the photon trajectory requires only that the differential cross section should be measured for fixed t and different s. If the interaction is γ_5–invariant, then one of these amplitudes asymptotically vanishes. The possibility of checking the γ_5–invariance on the basis of other experiments is discussed. (auth)

839 (JINR-P-1305) ASIMPTOTIKA GRAFOV FEINMANA. [PART] II. (The Asymptotic Behavior of the Feynman Graphs. [Part] II.). A. V. Efremov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 9p.

The asymptotic behavior ($S \to \infty$) of the divergent Feynman graphs is treated. It is shown that for the case of scattering the divergent part of the graph yields $\ln S$. Then the problem is essentially to determine the asymptotic behavior of the graph obtained from the initial one by contraction of the divergent part into a point. (auth)

840 (JINR-P-1318) METOD FREDGOL'MA RELYATIVISTSKOI ZADACHE RASSEYANIYA. (Fredholm Method in the Relativistic Problem of Scattering). B. A. Arbuzov, A. A. Logunov, A.T. Filippov, and O. A. Krustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 24p.

The solutions of the linear integral equation that were found by Fredholm method are investigated. This equation describes elastic scattering of spinless particles with equal masses in a certain bounded energy region, the magnitude of the momentum transfer being arbitrary. Analytical properties of the scattering amplitude as a function of complex variables of energy (or momentum) and the orbital momentum are studied. The asymptotic behavior of the partial amplitude at $|l| \to \infty$ is found, and the possibility of representing the total scattering amplitude as a Watson-Zommerfeld integral is shown. The analyticity of the total amplitude as a function of t is proved, and the conditions are formulated under which it has the Regge asymptotic behavior at $t \to \infty$ or $u \to \infty$. (auth)

841 (JINR-P-1336) METOD OPREDELENIYA KORNEI AMPLITUDY PION-NUKLONNOGO RASSEYANIYA VPERED. (A Determination of Zeroes of the Pion-Nucleon Forward Scattering Amplitude). Wit Romual'd (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 8p.

It is proved that the forward scattering amplitude $T^{(1)}(\omega)$ for pions on nucleons may have zeroes on the imaginary or real axis only. A method for determining the zeroes is presented. The impossibility of bringing the experimental data for the zeroes of the backward scattering amplitude $T^{(1)}(1) < 0$ into agreement with the value of $T^{(1)}(0) > 0$ is shown. (auth)

842 (JINR-P-1334) SPEKTRY ZARYAZHENNYKH MEZONOV POD UGLOM 90° OT (n,p)-SOUDARENII PRI ENERGII NEITRONOV ~600 Mev. (The Charged Meson Spectra in (n,p) Collisions at 90° for 600-Mev Neutrons). K. O. Oganesyan and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 9p.

The charged meson spectra in the interaction $n - p \to \pi^{\pm} + \ldots$ were measured in the photoemulsion chamber at an angle 90° in the laboratory system for 600-Mev neutrons. The π^+ to the π^- meson yield ratio was found to be 0.94 ± 0.10. The obtained results are in agreement with magnetic spectrometer measurements. (auth)

843 (JINR-P-1337) TROINOE RASSEYANIE PROTONOV PRI ENERGII 660 Mev. IV. UGLOVAYA ZAVISIMOST' PARAMETRA A. (Triple Proton Scattering at an Energy of 660 Mev. IV. Angular Dependence of the Parameter A). Yu. P. Kumekin, M. G. Meshcheryakov, S. B. Nurushev, and G. D. Stoletov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 15p.

Further experiments on triple proton scattering are described, and the results of measurements on the parameters A for cms angles of 54, 72, 90, 108, and 126° are reported. The data obtained are used for a direct reconstruction of the p-p scattering matrix, as well as for a comparison with the results of different versions of the phase shift analysis. (auth)

844 (JINR-P-1348) POLUFENOMENOLOGICHESKOE OPISANIE KOMPRONOVSKOGO RASSEYANIYA NA SISTEME SO SPINOM 1/2. (A Semiphenomenological Description of Compton Scattering on Spin-1/2 Systems). V. S. Barashenkov, G. Yu. Kaizer, E. E. Kapustsik, and Ya. S. Kvetsinski (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 12p.

The effective cross section in the general case of gamma elastic scattering on arbitrary spin-$^1/_2$ systems is expressed in terms of six form factors. In the case when the gamma energy is much less than the meson(π) mass, the cross section is expressed in terms of the electric charge, the anomalous magnetic moment, and the electric and magnetic polarizabilities of the scattering system. For elastic scattering on protons, the expression obtained agrees well with experimental data for gamma energies of 100 to 150 Mev if the proton electric and magnetic polarizabilities are 9×10^{-43} and 2×10^{-43} cm^3, respectively. Analytic expressions for the polarizabilities are obtained using double dispersion relations. (auth)

845 (JINR-P-1367) K USTANOVLENIYU KVANTOVYKH CHISEL MNOGOMEZONNYKH SISTEM. (About the Determination of the Multimeson Systems Quantum Numbers). G. I. Kopylov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 9p.

The volume of various configurations of the momenta of four mesons in phase space is calculated. The concept of the forbiddenness strength for the configurations that are forbidden by the quantum numbers of the multimeson system is introduced. Based on the calculation of the forbiddenness strength, it is possible to choose a set of quantities to be measured to determine the resonance spin and parity. The calculations are made for the decay of a particle with T = 0 and the mass $\approx$1 Bev on $3\pi^+ + \pi^-$. (auth)

846 (JINR-P-1368) O NEKOTORYKH SVOISTVAKH KASKADNOGO RASPADA. (On Some Properties of the Cascade Decay). G. I. Kopylov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 8p.

If the particles (1, 2, 3) effective mass is fixed, and the particles (2, 3) are decay products of the unstable particle a, then the particles (1, 2) effective mass distribution can simulate a resonance. If the particles (1, 2, 3) effective mass is varied, but the particles (2, 3) are the particle a decay products, then from the pair (1, 2) effective mass distribution the mass distributions of the triplet (1, 2, 3) and the pair (1, 3) and the mass of the unstable particle can be obtained. (auth)

847 (JINR-P-1375) FAZOVYI ANALIZ NUKLOV-NUKLONNOGO RASSEYANIYA PRI ENERGII 630 Mev. (Phase-Shift Analysis of Nucleon-Nucleon Scattering at 630 Mev). Yu. M. Kazarinov and V. S. Kiselev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 12p.

A combined phase shift analysis of n-p and p-p data was made. Three sets of phase shifts which have almost the same probability by the χ^2 criterion were found. (auth)

848 (JINR-P-1376) ENERGETICHESKAYA ZAVISIMOST FAZOVYKH SDVIGOV PRI RASSEYANII NUKLONOV NUKLONAMI V OBLASTI ENERGII 23–126 Mev. (Energy Dependence of Phase Shifts in Nucleon-Nucleon Scattering in the Energy Region 23–126 Mev). Yu. M. Kazarinov, V. S. Kiselev, and V. I. Satarov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 27p.

The phase shift energy dependence was obtained by a phase shift analysis at 52 and 126 Mev. The energy dependence of a phase shift set was also investigated at 23.1 and 66 Mev. (auth)

849 (JINR-P-1380) PEREKHOD IZ KANALA V KANAL DLYA IZOTOPICHESKIKH AMDLITUD. (Crossing Relations for Isospin Amplitudes). R. M. Muradyan and Ts'ung-mo Ch'ên (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 4p.

Relations for the transition from one channel to another were obtained for arbitrary isospin amplitudes. In the case of a "4-point function," the crossing matrix is expressed in terms of Racah's coefficients; in the most general case of a "5-point function," the crossing matrix is proportional to Wigner-Fano's coefficient depending on 9 momenta. (auth)

850 (JINR-P-1381) K VOPROSU O SUSHCHESTVOVANII PSEVDOSKALYARNOGO MEZONA S NULEVOI MASSOI. (On the Existence of a Pseudoscalar Massless Meson). Nguyen Van-hieu (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 17p.

Some effects of the existence of a pseudoscalar massless meson are considered: corrections to the anomalous magnetic moment of leptons, to the Lamb shift of the hydrogen energy levels, and to the hyperfine structure of positronium. The effective static interaction potential between fermions at large distances and the radiation of long-wave mesons are also examined. Possibilities for discovering this particle are discussed. (auth)

851 (JINR-P-1389) AMPLITUDA VERTUAL'NOGO KOMPTON-EFFEKTA NA NUKLONAKH. (The Amplitude of Virtual Compton Scattering on Nucleons). E. Kapustsik (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 4p.

It is shown that the amplitude depends on the charge, the anomalous magnetic moment and one new constant in an approximation linear in the wave vectors of the incoming and scattered photons. (auth)

852 (JINR-P-1391) DAL'NEISHEE UTOCHNENIE FAZOVYKH SDVIGOV pp-RASSEYANIYA PRI 657 Mev. (A Further Investigation of pp-Phase Shifts at 657 Mev). L. S. Azhgirei, N. P. Klepikov, Yu. P. Kumekin, M. G. Meshcheryakov, S. B. Nurushev, and G. D. Stoletov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 9p.

Recent data on the angular dependence of the triple scattering parameter prompted a specification of the results on the p-p phase shift analysis at 657 Mev. A set of real parts of the phase shifts, mixing parameters, and absorption coefficients that describes the experimental data with statistical reliability was obtained. The uniqueness of the phase shift set obtained is upheld. (D.C.W.)

853 (JINR-P-1404) OB ASIMPTOTICHESKIKH SOOTNOSHENIYAKH MEZHOU POLYARIZATSIYAMI V PEREKRESTIYKH REAKTSIYAKH. (On Asymptotic Relations Between the Polarizations in Crossed Channels). S. M. Bilenkii, Nguyen Van Hieu, and R. M. Ryndin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 12p.

Asymptotic relations between the polarizations in crossed channels were obtained. It was shown that the polarizations of the recoil protons in elastic π^+ and π^- scattering on protons are equal in magnitude and opposite in sign at high energies. The polarizations in the scattering of nucleons and antinucleons on nucleons and in reac-

tions involving strange particles were also examined. (auth)

854 (NP-13247) PROTON-PROTON ELASTIC SCATTERING AT 22.9 Gev (thesis). Erwin Marquit (Warsaw. Univ. Inst. of Theoretical Physics). Feb. 1963. 117p.

Proton-proton elastic scattering at 22.9 Bev was studied in emulsion by the normal incidence technique. A total of 30 two-prong stars satisfied the kinematical criteria for elastic interactions between beam protons and free protons of the emulsion, which corresponds to an observed elastic cross section $\sigma_e = 11.7 \pm 2.1$ mb for cms scattering angles $\theta > 0.8°$. It is shown that, due to the high resolution of the measurements, the possible background due to inelastic events in the sample of events classified as elastic cannot have any appreciable effect on the results. Partial correction for scanning losses based on the comparison of the results of different scannings yields the value $\sigma_e = 12.1$ mb (without Coulomb scattering), but in view of the difficulties connected with the estimation of the scanning efficiency, no meaningful error can be given for this corrected value. It is shown, however, that apart from the statistical errors, this value should be regarded as a lower limit. The results of the experiment indicate that for small scattering angles the differential cross section curve rises above the optical point, an effect that was observed in a large number of experiments above 2.5 Bev. A review of p-p elastic scattering experiments in the Bev region shows that many of the experimental techniques employed result in systematic errors that usually lead to the underestimation of the elastic cross sections. (auth)

855 (PAN-386/VI) ON THE ERRORS IN THE MOMENTUM ESTIMATION OF PARTICLES FROM THE TRACK CURVATURE IN A MAGNETIC FIELD. L. Michejda (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 14p.

The dependence of the measurement error and the error due to multiple Coulomb scattering on the number of measured points equally spaced along a track is given for the estimation of track curvature by the method of least squares. (auth)

856 (PAN-387/VII) APPROXIMATE COUPLED INTEGRAL EQUATION FOR PARTIAL K^+-N SCATTERING AMPLITUDES. M. Sewerynski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Jan. 1963. 22p.

Approximate coupled integral equations for partial K^+-N scattering amplitudes are obtained using a method based on the Shirkov approach to the double integral representation technique in the low energy region. (auth)

857 (PAN-399/VI) ENERGY SPECTRUM OF PHOTONS FROM DECAY OF π^0 MESONS GENERATED IN NUCLEAR INTERACTIONS AT THE ALTITUDE OF 3200m ABOVE SEA LEVEL. J. Babecki, Z. Buja, J. Massalski, and B. Nizioł (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 18p.

Apparatus with an area of 10 m^2, containing 6 layers of ionization chambers placed between lead and graphite absorber, was installed at 3200 m above sea level. The apparatus contained a layer of nuclear emulsion plates with the aid of which the energy spectrum of photons from the decay of π^0 mesons generated in graphite absorber was studied. The spectrum constructed on the base of 154 events in the energy interval 2×10^{11} to 4×10^{12} ev has the exponent $\gamma = 2.0 \pm 0.3$. (auth)

858 (PAN-436/XVIII) TWO-PARTICLE COLLISIONS. I. GENERAL RELATIONS FOR COLLISIONS IN THE LABORATORY SYSTEM. Michal Gryzinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1963. 61p.

The relations between the energies and angles for two-particle collisions are derived in the laboratory system of coordinates for the case of conservative central forces. The dependence of the law of interaction enters the obtained relations through the function for the o.m.s. scattering angle. The statistics of encounters are considered, and the cross sections for collisions in which the colliding particles experience given changes in energy and direction are derived. The cross sections suggest that the diffraction pattern of scattered particles, independently of the law of interaction, is due to quantized states of the scattering particles. (auth)

859 (PAN-447/XVIII) TWO-PARTICLE COLLISIONS. II. COULOMB COLLISIONS IN THE LABORATORY SYSTEM OF COORDINATES. Michal Gryzinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 49p.

Coulomb interactions are analyzed on the basis of a previously presented general theory of two-particle collisions. The exact angular and energy relations for two-particle collisions and the associated cross sections are derived and presented explicitly in the laboratory system of coordinates. Fairly simple approximations that provide sufficient exactness for most calculations, while emphasizing the main features of the Coulomb interaction, are also obtained. (D.C.W.)

860 (TID-19565) POSITION OF RESONANCE POLES NEAR THE THRESHOLD OF A CHANNEL. Marc Ross (Indiana. Univ., Bloomington and California. Univ., Berkeley. Lawrence Radiation Lab.). [1963]. Contract AT(11-1)-1112. 14p.

The position of s-matrix resonance poles in a multichannel situation when the resonance is near the threshold of one of the coupled channels is discussed with emphasis on the known association (usually) of more than one s-pole with any resonance. (D.C.W.)

861 (TID-19566) VALIDITY OF THE "MASS-FORMULA" FOR THE BARYON DECUPLET RESONANCES. Marc Ross (Michigan. Univ., Ann Arbor). [1963]. Contract AT(11-1)-1112. 10p.

The validity of describing the observed lack of symmetry of the assumed decuplet of baryon resonances as a perturbation for the mass formula expressing particle mass deviation from full degeneracy under SU_3 symmetry is investigated. Definitions of resonance position are examined, and the conditions necessary for perturbation theory to be accurate are considered. The mass formula is re-evaluated for the case of the baryon decuplet. (D.C.W.)

862 (TID-19590) REPORT OF RESEARCH IN HIGH ENERGY NUCLEAR PHYSICS, NOVEMBER 1, 1962 THROUGH OCTOBER 31, 1963. (Carnegie Inst. of Tech., Saxonburg, Penna. Nuclear Research Center). Contract AT(30-1)-882. 25p.

Research progress on elementary particle interactions, properties, scattering, and theory; nucleon reactions and scattering; spark chambers; superconducting magnet bubble chambers; beam production and handling; and solution of integral equations is reported. (D.C.W.)

863 (TID-19604) $K_1^0 \rightarrow \gamma + \gamma$ DECAY MODE. V. Barger (Wisconsin. Univ., Madison). Sept. 25, 1963. Contract AT(11-1)-30. 18p.

The mechanism for the rare radiative decay mode $K_1^0 \rightarrow 2\gamma$ is treated as the virtual disassociation of K_1^0 into a $\pi^+ - \pi^-$ pair followed by internal annihilation of the pions into photons. Introducing a direct $K_1^0 - 2\pi$ interaction and using the techniques of dispersion theory, the branching ratio $\Gamma(K_1^0 \rightarrow 2\gamma)/\Gamma(K_1^0 \rightarrow \pi^+ + \pi^-)$ is expressed in terms of the I = 0, s-wave π-π scattering phase shifts. With negative and small positive π-π scattering lengths, numerical estimates indicate no appreciable enhancement of the branching ratio from its perturbation theory value: 0.24×10^{-5}. Branching ratios of the order of 10^{-4} to 10^{-3} are obtained for large positive scattering lengths provided that the high energy behavior of the phase shifts has a specified character. (auth)

864 (UCRL-10243) A STUDY OF THE REACTION $\pi^+ + p \rightarrow \Sigma^+ + K^+$ NEAR THRESHOLD AND AT 1170 Mev/c. Frank S. Crawford, Jr., Fernand H. Grard, and Gerald A. Smith (California. Univ., Berkeley. Lawrence Radiation Lab.). May 11, 1962. Contract W-7405-eng-48. 21p. (CONF-295-1)

From International Conference on High Energy Physics, Geneva, July 4-11, 1962.

A 72-inch hydrogen bubble chamber was exposed to Bevatron π^+ beams of 1050 and 1170 Mev/c. The data were analyzed in terms of production partial-wave amplitudes, and were compared with those available for Σ^0 and Σ^- production in the same energy region to test the charge-independence hypothesis. The amplitudes, angular distributions, and polarizations obtained are included. (auth)

865 (UCRL-10731) PION-PION RESONANCE FROM PION-NUCLEON INELASTIC INTERACTIONS. Zaven G. T. Guiragossian (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 13, 1963. Contract W-7405-eng-48. 51p.

A 3.3-Bev/c π^- beam was used to study the π-π system in π-p interactions. Events were analyzed by the FOG-CLOUDY-FAIR data reduction system. 532 $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ ($\pi^-\pi^+$ system, T = 0, 1, 2) (1) and 365 $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ ($\pi^-\pi^0$ system, T = 1, 2) (2) events were identified. If high-energy interactions are dominated by a Regge pole having the quantum numbers of the vacuum (T = 0, J parity even), then such a pole should manifest itself in the physical region as a π-π resonance in the T = 0, J = 2 state, at a π-π barycentric energy of ω = 1000 to 1300 Mev. The distribution in ω for reactions (1) and (2) is strongly peaked at 775 Mev, which accounts for the T = 1 ρ^0 and ρ^- mesons, respectively. Moreover, reaction (1) has a second peak at a central value of 1250 Mev. The possibility that this peak is the T = 0, J = 2 π-π resonance is discussed. The resonant behaviors of the peaks are studied by means of the decay angular distribution of the final π^- in the π-π barycentric system. Dalitz plots were constructed for both reactions. Evidence for the N_η^* (1238) resonance is found in the π^0-p system, whereas N^* resonances in other states seem to be absent. (auth)

866 (UCRL-10949) PION SCATTERING FROM A POLARIZED TARGET. Owen Chamberlain, Carson D. Jeffries, Claude H. Schultz, Gilbert Shapiro, and Ludwig Van Rossum (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 7, 1963. Contract W-7405-eng-48. 17p. (CONF-46-105)

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

The parameter P, equivalent to that determined by analyzing the recoil proton polarization in scattering from an unpolarized target, was measured to an unprecedented accuracy at an energy and angles inconvenient for double-scattering techniques by detecting pion-proton coincidences in 246-Mev meson (π^+) scattering by a target containing polarized protons. (D.C.W.)

867 SPACE-TIME STRUCTURE AND MASS SPECTRUM OF ELEMENTARY PARTICLES. J. I. Horváth (Univ. of Szeged). Acta Phys. Acad. Sci. Hung., 16: 77-92 (1963).

Experiments proving the violation of parity conservation have recently led to the assumption that the structure of the space-time continuum, in agreement with the modern philosophical concept of the space-time world as being determined by real physical interactions, may be anisotropic. In fact, this assumption can be also expressed by saying that the physical fields excited in such an anisotropic space have internal degrees of freedom. First of all the derivation of the field equations is discussed for fermions, in particular considering second order equations. Then it is proved that a mass spectrum of elementary particles exists and, based on a provisional Lagrangian of baryons, the mass spectrum of the latter can be calculated in good agreement with the experiments. At the same time an interpretation is suggested of the strangeness and of the multiplicity of the different isodoublets. (auth)

868 NEUTRINO RADIATION FROM DEGENERATE GASES. G. Marx and T. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 16: 141-53(1963).

The production cross section of neutrino pairs in the nuclear Coulomb field is calculated. The Coulomb screening is also taken into account. A separate discussion is devoted to the presence of a degenerate electron gas. Its importance is shown for low energies. The results may have some astrophysical consequences, especially for the interior of degenerate stars during the late period of their evolution in the temperature interval 10^8 to $10^{9.5}$K. (auth)

869 ON PARTIALLY CONSERVED CURRENTS. Sidney Coleman (Harvard Univ., Cambridge, Mass.). Ann. Phys. (N. Y.), 24: 37-45(Oct. 1963).

It is observed that the hypothesis of partially conserved leptonic weak interaction currents implies that the fundamental meson–baryon interaction be invariant under a certain group constructed from these currents. The only candidate for this group that is consistent with experiment and that does not require the introduction of an exorbitant number of spinless mesons is the eight-dimensional rotation group. The associated meson–baryon coupling is one first proposed by Gürsey. This group does not seem to have any connection with the approximate symmetries of the strong interactions; thus the notion of partially conserved currents is rejected. (auth)

870 SOME EXAMPLES OF THE ASYMPTOTIC FIELD—IN THE SENSE OF WEAK CONVERGENCE. Hiroshi Ezawa (Tokyo Univ.). Ann. Phys. (N. Y.), 24: 46-62(Oct. 1963).

The model of the boson field interacting with a fixed fermion field and the Lee model are used to illustrate the asymptotic behavior of the field operators. The fading of the canonical commutation relations is a common feature of both models. The asymptotic field is constructed as a weak limit. It is concluded generally that the field operators never converge strongly if the particles get clothed. (C.E.S.)

871 POINT TRANSFORMATIONS AND THE MANY BODY PROBLEM. M. Eger and E. P. Gross (Brandeis

Univ., Waltham, Mass.). Ann. Phys. (N. Y.), 24: 63-88 (Oct. 1963).

An investigation is made of possible uses of many dimensional coordinate transformations in the quantum many-body problem. The transformed hamiltonian is quadratic in the momenta with a space dependent metric. The original potential energy undergoes alteration and an additional metric potential energy appears. A relatively complete analysis of the transformed original potential is made, and the coordinate transformation can be used to suppress undesirable features of the original potential. For bosons one can attempt to directly map a complete set of noninteracting states onto approximate eigenstates of the system with interactions. Contact is made with a theory of weakly interacting bosons. In the general case it emerges that a given transformation uniquely fixes all the spatial correlation functions, which can be explicitly computed. The extended point transform can then be used as a link between diverse experimental quantities. The full use of the transformation to compute from first principles requires adequate approximations to the Jacobian and the inverse transform. (auth)

872 NUCLEON COMPTON SCATTERING. I. DISPERSION RELATIONS. Dennis Holliday (Univ. of Oregon, Eugene). Ann. Phys. (N. Y.), 24: 289-318(Oct. 1963).

Nucleon Compton scattering is analyzed assuming the validity of the Mandelstam representation. The six covariant amplitudes that determine the scattering amplitude for this process are chosen in such a way that no kinematical singularities are introduced. From the analytic properties of the covariant amplitudes implied by the Mandelstam representation, subtracted dispersion relations are written for quantities that are simply related to the elements of the total angular momentum submatrices of the scattering matrix; the subtraction constants are determined from an application of the low-energy Compton scattering theorem. The one-particle intermediate state contributions to the absorptive parts are considered exactly. The two-particle intermediate state contributions to the absorptive parts in Channels I and II are approximated by using the matrix elements of the Chew, Goldberger, Low, and Nambu single pion photoproduction analysis. For the two-particle intermediate state contribution to the absorptive part in Channel III a pole-term approximation is used after the I = 0 amplitude alone is shown to contribute. No higher mass intermediate states in any channels are considered. (auth)

873 NUCLEON COMPTON SCATTERING. II. COMPARISON WITH EXPERIMENTAL DATA. Dennis Holliday (Univ. of Oregon, Eugene). Ann. Phys. (N. Y.), 24: 319-31(Oct. 1963).

The proton Compton scattering cross section resulting from a numerical evaluation of nucleon Compton scattering dispersion relations is compared with experimental data at 90 and 135° center of mass from 0 to 300-Mev incident photon energy. Below 240 Mev the cross section at 90° is best approximated by the dispersion-theoretic amplitude that omits the contribution from the $2-\pi$ intermediate state in Channel III, while the cross section at 135° is best approximated by the amplitude that includes this contribution. Above 240 Mev the approximations made in the absorptive part in Channel I result in a rapid deterioration of the predictions. The effect of the contribution from the heretofore neglected $2-\pi$ intermediate state in Channel III is considered and is used to dispute the validity of previous predictions of the neutral pion lifetime based upon proton Compton scattering dispersion relations. (auth)

874 THE PARITY OF THE NEUTRAL K MESON. Richard Spitzer (Argonne National Lab., Ill. and Univ. of California, Livermore). Nucl. Phys., 47: 367-84(Sept. 1963). (UCRL-7332-T)

An experiment is suggested to test the conjecture that the intrinsic parity of the neutral K meson is imaginary. The presence of the coupling assumed to specify this parity will manifest itself in a dependence of the effective $K_1 - K_2$ mass difference on the component of an external magnetic field parallel to the K momentum and, if the coupling is sufficiently strong on the product $E \cdot H$ of external electric and magnetic fields. The determination of the parity of the neutral K to be imaginary would necessitate a modification in the current viewpoint regarding the limitations in the physical significance of the relative intrinsic parities of strongly-interacting particles. Specifically it would result in the explanation of the phenomenon of associated production on the basis of invariance under space inversion alone. The theory provides a simple explanation, in the case of nonneutrino decays, of the simultaneous breakdown of associated production and parity conservation. The equality of the domains of validity of these two seemingly distinct phenomena reduces to their physical identity when the limits of these domains are defined by such decays. It is shown that relative intrinsic parities of spin-$\frac{1}{2}$ particles that transmute into each other can be determined to be imaginary by observing transitions between suitable direct-product states of these particles, and parity violation can be explained in terms of intrinsic parities. Both results conflict with generally held views. The essential conclusions are consequences of the restrictions on the set of observables (superselection rules) imposed by the intrinsic space-inversion properties of the particles. The concept of superselection is itself redefined so that it can be applied to the characterization of the restrictions on the set of observables whether the pertinent symmetry is exact or approximate. (auth)

875 THEORY OF ELEMENTARY PARTICLES AND THEIR INTERACTIONS IN THE ISOSPACE $\mathfrak{C}(R_3^c)$. P. Hillion (Institut H. Poincaré, Paris). Nuovo Cimento (10), 26: Suppl. No. 1, 113-68(1962). (In French)

A theory is considered in which the elementary particles are conjectured to have a structure reducible, in a classical model, to a point in the Minkowski universe along with a group of complex trihedra in rotation about this point. In the quantum description, elementary particles are described in terms of a system of fields of the space $\mathfrak{C}(R_3^c)$ constructed over the ring $v(R_3^*)$ of the representation of the group R_3^* by complex orthogonal 3×3 matrices. This theory is elucidated; in the theory, the strong, weak, and electromagnetic interactions are studied and related to various groups and fields. (T.F.H.)

876 SCATTERING DISPERSION RELATIONS FOR STABLE AND UNSTABLE PARTICLES IN PERTURBATION THEORY. A. Minguzzi (Università, Bologna). Nuovo Cimento (10), 26: Suppl. No. 1, 178-89(1962).

Contributions from two diagrams (the so-called direct and exchange diagrams) are considered in the interaction $p_A + p_B \rightarrow p_{A'} + p_{B'}$. The dispersion relation for the interaction is determined in terms of the contributions of these diagrams. The effect upon the dispersion relation of taking one of the interacting particles to be unstable is also shown. (T.F.H.)

877 NEUTRAL PION PRODUCTION BY 17 Gev NEGATIVE PIONS IN CARBON. P. Babu, R. Cowsik, and Yash Pal (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 29: 785-800(Aug. 16, 1963).

Neutral π-meson production by 17-Bev/c negative π mesons incident on carbon nuclei was studied. It is found that a great majority of the neutral π mesons is produced isotropically in the barycentric system of the incident π-meson and a target π meson at rest in the laboratory system. The energy spectrum of the neutral π mesons in the laboratory system is much steeper than the corresponding spectrum obtained in proton collisions. It is shown that energetic π mesons from the decay of the forward nucleon isobar produced in proton collisions may account for most of this difference. Elastic charge exchange probability per collision is found to be less than 1/530. Average transverse momentum of neutral π mesons is found to be (220 ± 10) Mev, which is significantly smaller than the corresponding value for charged π mesons as determined in bubble chamber experiments. (auth)

878 THE DEUTERON FORM FACTOR AND DISPERSION THEORY. J. Nuttall (St. John's Coll., Cambridge, Eng.). Nuovo Cimento (10), 29: 841-50(Aug. 16, 1963).

The divergences of the dispersion integral that result from substituting the absorptive part from the lowest singularity are considered, and the extent to which higher thresholds may cancel them is discussed. (auth)

879 $\Delta Q = -\Delta S$ DECAYS AND INTERMEDIATE BOSONS. L. Wolfenstein (Carnegie Inst. of Tech., Pittsburgh). Nuovo Cimento (10), 29: 859-66(Aug. 16, 1963).

The experimental facts (1) vanishing of $K_1^0 - K_2^0$ mass difference in lowest order, (2) $\Delta Q = -\Delta S$ leptonic decays, and (3) domination of $\Delta S = 1$ nonleptonic decays by $\Delta T = \frac{1}{2}$ transitions are shown to be consistent with an extension of d'Espagnat's veton theory involving four intermediate bosons, two positive and two negative. The theory is contrasted with those of Behrends and Sirlin and Lee, which involve six bosons (including two neutral ones) and yield an exact $\Delta T = \frac{1}{2}$ rule instead of the approximate one. There are two general predictions: (1) $\Delta T = \frac{1}{2}$ for those leptonic decays with $\Delta Q = \Delta S$ and (2) no forbiddenness of $\Delta S = 2$ leptonic decays. (auth)

880 PION DIFFRACTION DISSOCIATION OF CARBON NUCLEI AT 6.1 AND 18.1 Gev/c. G. Bellini, E. Fiorini, A. J. Herz, P. Negri, and S. Ratti (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 29: 896-917(Aug. 16, 1963).

Three-prong interactions by π^- mesons of 6.1 and 18.1 Bev/c were studied in a heavy-liquid bubble chamber. It was found that while most of the events at 6.1 Bev/c can be interpreted on the basis of a peripheral collision on a neutron, a large proportion of 18.1 Bev/c events cannot be interpreted in this way. They appear to be due to diffraction dissociation on a carbon nucleus acting coherently. At both incoming momenta the invariant mass distribution of the three secondary pions show a bump in the region about 1200 Mev/c^2. At 18.1 Bev/c this bump can be explained as due to phase-space contraction in the diffraction process. However, the existence of a similar bump at 6.1 Bev/c, where the diffraction dissociation on nuclei does not occur, may be explained either by the occurrence of diffraction dissociation on bound neutrons or by the existence of a resonant state at about 1200 Mev/c^2. (auth)

881 HIGH-ENERGY π-MESON-NUCLEON BACKSCATTERING USING REGGE POLE HYPOTHESIS. H. Ueberall (Univ. of Michigan, Ann Arbor). Nuovo Cimento (10), 29: 947-53(Aug. 16, 1963).

Backscattering of π mesons by nucleons may provide a method to study experimentally the Regge trajectories of the nucleon and its resonances. Using the Regge pole hypothesis, the asymptotic behavior of the large-angle differential cross section and recoil nucleon polarization in the limit of high energies was calculated. The interferences among the three known trajectories are obtained, as well as their interferences with Gribov's conjugate trajectories, which may lead to oscillations in the cross section and polarization. (auth)

882 POLARIZATION OF HYPERONS IN THE REACTION $\nu + N \rightarrow Y + 1$. L. Egardt (Uppsala Univ.). Nuovo Cimento (10), 29: 954-61(Aug. 16, 1963).

General expressions are given for the polarization of hyperons produced in high-energy neutrino reactions. Particular emphasis is placed on the longitudinal polarization. Numerical results are given for an incident neutrino energy of about 1 Bev. (auth)

883 $\bar{K}$-NUCLEON INTERACTIONS AND THE POSSIBILITY OF Y_0^*-RESONANCE AS A BOUND STATE OF THE K-N SYSTEM. Ramesh Chand (Syracuse Univ., N. Y.). Nuovo Cimento (10), 29: 967-76(Aug. 16, 1963).

In the zero-range boundary conditions method of Dalitz and Tuan for coupled $\bar{K}N$-πY channels, interactions of $\bar{K}$ mesons with nucleons are discussed. The low-energy K^--p data are described in terms of three sets of scattering parameters. Using these parameters, the possibility of an $I = 0$, π-Σ resonance at 1405 Mev as an s-wave bound state of $\bar{K}$-nucleon system is investigated. (auth)

884 ON THE CERENKOV ABSORPTION OF ELECTROMAGNETIC RADIATION. A. B. Kukanov. Opt. Spectry. (USSR) (English Transl.), 15: 62-3(July 1963).

The acceleration of charged particles by the Cherenkov absorption of electromagnetic radiation is considered. The case of a Dirac electron moving a dense transparent medium without boundaries in the presence of electromagnetic radiation pumped into the medium is discussed. The maximum value of the electron acceleration gained as a result of Cherenkov absorption of transversal isotropic radiation and induced emission is calculated. Different types of energy losses resulting from ionization, bremsstrahlung, and deviations resulting from scattering are also considered. (C.E.S.)

885 ON THE CERENKOV RADIATION PRODUCED BY MAGNETIC AND ELECTRIC MOMENTS IN A TRANSPARENT UNIAXIAL CRYSTAL. A. B. Kukanov and Tkhai Kuan. Opt. Spectry. (USSR) (English Transl.), 15: 63-4 (July 1963).

The energy loss due to Cherenkov radiation produced by magnetic and electric moments in a transparent uniaxial ferroelectric is calculated. The method used makes it possible to reduce a complex integration to the calculation of several standard integrals. (C.E.S.)

886 ANALYSIS OF PARTIAL-WAVE DISPERSION RELATIONS. Graham Frye and Robert Lee Warnock (Univ. of Washington, Seattle). Phys. Rev., 130: 478-94 (Apr. 1, 1963).

Questions of existence and uniqueness of solutions of partial-wave dispersion relations are studied, with particular attention to the N/D method. The interaction, assumed to be given, is represented by (i) the strengths and locations of unphysical singularities and (ii) the inelastic partial-wave cross section. A generalization of the N/D method to include part (ii) of the interaction leads to a nonsingular integral equation for ImD. This equation is amenable to the Fredholm theory only if there is a correlation between items (i) and (ii) of the interaction, and only if the increase of inelastic processes at high energies is

not too rapid. Certain Cauchy integrals associated with (i) and (ii) must be nonzero at threshold if there is to exist a solution with the normal threshold momentum dependence. Thus, there is no solution for any model in which (i) is constructed from a few partial waves in the two crossed channels. For certain interactions the real part of the phase shift approaches a multiple of π at large energy, just as in potential scattering. The Castillejo-Dalitz-Dyson (CDD) ambiguity is analyzed in some detail. A uniqueness theorem is proved which asserts that if a solution of a particular type exists, it is the only solution of the problem within the class usually considered. Thus the CDD ambiguity is partially bypassed. In certain cases the unique solution is found by the ordinary N/D method without subtractions. Some useful results on principal value integrals are obtained. The discussion is carried out for the example of pion-nucleon scattering in the complex plane of w, the center-of-mass energy. The behavior of the amplitude near $w = \pm(M-m)$ is derived from crossing symmetry. (auth)

887 VIOLATION OF $|\Delta| = \frac{1}{2}$ RULE IN THE $K^0_{\pi 3}$ DECAY AND THE $K^0_2 \rightarrow \gamma + \gamma$ DECAY. S. Oneda and S. Hori (Kanazawa Univ., Japan). Phys. Rev., 132: 1800-2(Nov. 15, 1963).

It is assumed that the major part of the violation of the $\Delta I = \frac{1}{2}$ rule in $K_{\pi 3}$ decay comes from the chain of processes $K^0 \rightarrow \eta \rightarrow \pi^+ + \pi^- + \pi^0$. With this assumption, a relation is obtained between the coupling constant $f_{K^0\eta\pi^0}/4\pi$ and the width $\tau(\eta \rightarrow \pi^+ + \pi^- + \pi^0)$. The experimental value of the branching ratio $\tau(\eta \rightarrow \text{neutrals})/\tau(\eta \rightarrow \pi^+ + \pi^- + \pi^0) \approx 3.0$ is used to infer the unknown branching ratio $\tau(\eta^0 \rightarrow 2\gamma)/\Gamma(\eta^0 \rightarrow \pi^+ + \pi^- + \pi^0)$ and the theory of unitary symmetry to deduce the value of the width $\tau(\eta^0 \rightarrow 2\gamma)$ from the experimental decay rate of $\pi^0 \rightarrow 2\gamma$. If only pion and η-meson pole terms are responsible for the mass difference $m(K^0_1) - m(K^0_2)$. The value of the coupling constant $f_{K^0\pi^0\pi^0}/4\pi$ can also be derived. These two coupling constants $f_{K^0\eta\pi^0}/4\pi$ and $f_{K^0\pi^0\pi^0}/4\pi$ are illustrated as a function of the deviation x from the $\Delta I = \frac{1}{2}$ rule. Under the same assumption a result is obtained that $\Gamma(K^0_2 \rightarrow 2\gamma)$ is comparable to $\Gamma(K^0_2 \rightarrow \pi^+ + \pi^- + \pi^0)$ or is negligibly small according as $f_{K^0\pi^0}$ and $f_{K^0\eta^0}$ are of the same sign or not. If the deviation $x = 30\%$ is really correct, the decay rate of $\Sigma^- \rightarrow \eta + \pi^-$ can be explained with $g_{\Sigma^0 nK^0}/4\pi \lesssim 1$. On the other hand, if the extended $\Delta I = \frac{1}{2}$ rule is valid for the couplings of $K - \pi$ and $K - \eta$, the following results are obtained: $x = 15\%$, $m(K^0_1) < m(K^0_2)$, $f_{K^0\pi^0\pi^0}/4\pi = 2.8 \times 10^{-16}$, $\Gamma(K^0_2 \rightarrow 2\gamma) = 8 \times 10^3\ \text{sec}^{-1}$ and the decay rate $\Sigma^- \rightarrow n + \pi^-$ can be fitted with $g_{\Sigma^0 nK^0}/4\pi \approx 6$. Precise experiments are desired on the decay $K^0_2 \rightarrow 2\gamma$ as well as on the decay $K^0_2 \rightarrow \pi^+ + \pi^- + \pi^0$. (auth)

888 REGGE POLES AND THE PHOTOPRODUCTION OF PIONS. R. W. Childers and W. G. Holladay (Vanderbilt Univ., Nashville). Phys. Rev., 132: 1809-18(Nov. 15, 1963).

The photoproduction of pions, $\gamma + N \rightarrow \pi + N$, is examined from the standpoint of the Regge pole hypothesis and the Mandelstam representation. The asymptotic behavior of the forward scattering amplitudes is determined in terms of the Regge trajectories of the $\gamma + \pi \rightarrow N + \bar{N}$ channel. The ρ, ϕ, and ω trajectories are included in the description of the photoproduction of neutral pions, whereas only the ρ and π trajectories contribute to the photoproduction of charged pions. In the case of backward scattering, asymptotic representations of the scattering amplitudes are controlled by the trajectories of the $\gamma + N \rightarrow \pi + N$ channel by crossing. Generalized Pomeranchuk relations are established for the differential cross sections in the forward and backward directions for the various charge configurations of the photoproduction channel. The following interesting results are obtained: (1) The differential cross sections for $\gamma + p \rightarrow n + \pi^+$ and $\gamma + n \rightarrow p + \pi^-$ are asymptotically equal in the forward and backward directions; (2) the differential cross sections for $\gamma + p \rightarrow p + \pi^0$ and $\gamma + n \rightarrow n + \pi^0$ are asymptotically equal in the backward direction. (auth)

889 π^--p INTERACTIONS AT 905, 960, AND 1100 Mev. E. Pickup, D. K. Robinson, E. O. Salant, F. Ayer, and B. A. Munir (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 1819-30(Nov. 15, 1963). (BNL-7125)

Single-pion production in π^--p interactions was studied at 905, 960, and 1100 Mev. Comparison with the isobar and one-pion-exchange (OPE) mechanisms of pion production shows that, below 1 Bev, pion production occurs primarily through the formation of an intermediate excited state of the nucleon (isobar), while at higher energies the influence of the ρ resonance in the $\pi\pi$ system becomes increasingly important. There is some evidence for an I = 2 state in the events at the lower energies. (auth)

890 ORIGIN OF INTERNAL SYMMETRIES. Ernest Abers (Univ. of California, Berkeley), Fredrik Zachariasen, and Charles Zemach. Phys. Rev., 132: 1831-6(Nov. 15, 1963).

Internal symmetries such as isotopic spin are not necessarily arbitrary constraints to be imposed at the beginning of a calculation. The bootstrap requirement that all particles be determined as composite states of one another leads naturally to symmetric solutions for masses and coupling constants. (auth)

891 LORENTZ-COVARIANT POSITION OPERATORS FOR SPINNING PARTICLES. T. F. Jordan and N. Mukunda (Univ. of Rochester, N. Y.). Phys. Rev., 132: 1842-8 (Nov. 15, 1963).

An examination is made of the consequences for the quantum mechanics of spinning particles of equations characteristic of Lorentz-covariant position variables. These equations are commutator analogs of the Poisson bracket equations that express the familiar transformation properties of space-time events in classical mechanics. For a particle of zero spin it is found that the usual canonical coordinate is the unique solution of these equations. For a particle with positive spin there is no position operator which satisfies these equations and has commuting components. For a particle and antiparticle there is a unique solution with commuting components which is valid for all values of the spin and reduces for zero spin to the canonical coordinate. For spin $\frac{1}{2}$ this is the Foldy-Wouthuysen transform of the position operator of the Dirac equation. A generalization of the inverse Foldy-Wouthuysen transformation, valid for any value of the spin, appears as a unique unitary transformation which takes this generalized Dirac position to the canonical coordinate. The application of this transformation to the canonical form of the Hamiltonian gives a generalization of the Dirac equation Hamiltonian. This is developed and compared with the literature for spin 1. It gives a nonlocal equation as the spin 1 analog of the Dirac equation. (auth)

892 PROTON-PROTON SCATTERING AND STRONG INTERACTIONS. Alan D. Krisch (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 11: 217-20(Sept. 1, 1963).

It is shown that high-energy differential cross section data for proton-proton scattering can be fit by a function that can be understood in terms of a simple model. (C.E.S.)

893 PHOTOPAIR PRODUCTION OF CHARGED, SEMIWEAKLY INTERACTING VECTOR BOSONS. William

Williamson, Jr., and George Salzman (Univ. of Colorado, Boulder). Phys. Rev. Letters, 11: 224-7(Sept. 1, 1963).

The total cross section for the coherent photopair production of charged, semiweakly interacting vector bosons in the Coulomb field of the nucleon Fe^{56} was calculated in the lowest order perturbation theory. (C.E.S.)

894 REACTION $\pi^+ + p \rightarrow \pi^+ + p + \omega$ AT 3.5 Bev/c. Nguyen-huu Xuong, Richard L. Lander, Werner A. W. Mehlhop, and P. M. Yager (Univ. of California, La Jolla). Phys. Rev. Letters, 11: 227-30(Sept. 1, 1963).

Mechanisms for meson (ω) production in the reaction $\pi^+ + p \rightarrow \pi^+ + p + \omega$ at 3.5 Bev/c are discussed. Experimental angular, mass, and momentum transfer distributions for the reaction are illustrated. (C.E.S.)

895 RELATION BETWEEN THE WIDTH OF THE OMEGA AND THE REACTION $\pi + \pi \rightarrow \pi + \omega$. William R. Frazer, Sharashchandra Patil, and H. Lee Watson (Univ. of California, La Jolla). Phys. Rev. Letters, 11: 231-3 (Sept. 1, 1963).

A model is proposed for relating the reaction $\pi^+ + \pi^0 \rightarrow \pi^+ + \omega$ to the decay $\omega \rightarrow \pi^+ + \pi^- + \pi^0$. The model relies on the dominance of the meson (ρ) intermediate state. The model is a result of the S-matrix approach if the approximation of considering only nearby singularities is made. (C.E.S.)

896 SEARCH FOR NEUTRINO-INDUCED REACTIONS. Alan Astbury and Kenneth M. Crowe (Univ. of California, Berkeley). Phys. Rev. Letters, 11: 234-7 (Sept. 1, 1963). (UCRL-10826)

Neutrino-induced reactions in a sodium iodide crystal were measured to obtain an upper limit for the value of the cross section for the reaction $\bar{\nu}_\mu + p \rightarrow \mu^+ + n$. A lower limit for the mass of the intermediate boson produced in the reaction was also obtained. (C.E.S.)

897 OPTICAL MODEL FOR THE PION-NUCLEON RESONANCES. E. H. Auerbach and B. Margolis (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 11: 286-7(Sept. 15, 1963). (BNL-7279)

Wave equations are used to investigate the dominant features of meson (π)-nucleon scattering in the resonance region. The interaction strength for various resonances are given and estimated elastic scattering widths are compared with previous experimental data for total widths. (C.E.S.)

898 EXPERIMENTAL STUDY OF THE CASCADE TIME OF NEGATIVE MESONS IN A LIQUID HELIUM BUBBLE CHAMBER. J. G. Fetkovich and E. G. Pewitt (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev. Letters, 11: 290-3(Sept. 15, 1963).

The cascade time of mesons (π^-) in liquid helium was measured. The results seem to rule out significant amounts of Stark effect and polarization capture in liquid helium. It appears that the measured cascade time is consistent with the assumption that radiation and external Auger effect are the primary cascade mechanisms. (C.E.S.)

899 DISCUSSION OF A SUGGESTED BOUND ON COUPLING CONSTANTS. C. Goebel and B. Sakita (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 11: 293-6 (Sept. 15, 1963).

A previously derived upper bound on coupling constants that depends only on the masses of the three particles involved is considered. It is concluded that the assumption on which the upper bound is based has no direct physical significance and hence the bound on coupling constants likewise has no physical significance. (C.E.S.)

900 IS G_2 OR SU_3 THE MORE SUITABLE SYMMETRY FOR STRONG INTERACTIONS? R. E. Behrends and L. F. Landovitz (Yeshiva Univ., New York). Phys. Rev. Letters, 11: 296-301(Sept. 15, 1963).

The implications of the Lie group G_2 for strong interactions were considered with special emphasis on those points for which SU_3 is considered successful. It is found that except for two crucial experimental results, G_2 is compatible with the present experimental knowledge of the spectra of the strongly interacting particles. The predictions of G_2 differ significantly from those of SU_3 only within the region of the resonances. (C.E.S.)

901 MODERATION TIME FOR NUCLEAR CAPTURE OF NEGATIVE PIONS IN LIQUID He^4. M. M. Block (Northwestern Univ., Evanston, Ill.), T. Kikuchi, D. Koetke, J. Kopelman, C. R. Sun, R. Walker, G. Culligan, V. L. Telegdi, and R. Winston. Phys. Rev. Letters, 11: 301-3 (Sept. 15, 1963).

A beam of slow mesons(π^-) was introduced into a He^4 bubble chamber to measure the mean time spent by a meson(π^-) in going from an initial velocity to nuclear capture and to obtain an accurate range spectrum of the prong produced in the nuclear capture of a meson(π^-) by He^4. (C.E.S.)

902 INVESTIGATION OF Y^* AND $\overline{Y}^*$ PRODUCTION IN REACTIONS OF THE TYPE $\bar{p} + p \rightarrow Y + \overline{Y} + \pi$. C. Baltay (Yale Univ., New Haven), J. Sandweiss, H. D. Taft, et al. Phys. Rev. Letters 11: 346-9(Oct. 1, 1963). (BNL-7184)

The observation of Y_0^*, Y_1^* and their antiparticles in $\bar{p}$-p reactions leading to three-body final states of the form $Y + \overline{Y} + \pi$ is reported. It is found that these reactions proceed primarily by resonance production. The reactions show excellent agreement with the single-K or -K* exchange model. An analysis of the masses and widths of the Y_0^* and Y_1^* states yields results consistent with previous determinations. (C.E.S.)

903 PHOTOPRODUCTION OF π-MESONS CLOSE TO THE THRESHOLD. A. M. Baldin. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 3-36(1963). (In Russian)

The photoproduction of mesons(π) close to the threshold energy is considered. A picture of the work performed at the Lebedeff Physical Institute 280-Mev electron synchrotron is presented. The dispersion relation method was applied to the theory of meson(π) photoproduction from nucleons. Experimental data are analyzed on the basis of the dispersion relation. The differential cross section calculated for the axis $(d\sigma/d\Omega)_{t=0}$ was found to agree with the experimental results, for the production of both charged and neutral mesons(π). The photoproduction of mesons(π) from deuterium is also discussed from the dispersion relation standpoint. The total cross section data for the reaction $\gamma + d \rightarrow 2p + \pi^-$ from 157 to 182 Mev were found to agree within experimental error with a curve representing the square of the Born portion of the amplitude for the process $\gamma + n \rightarrow p + \pi^-$. The data are not accurate enough to determine whether or not the term $|K_{33}|^2$ increases with decreasing energy. (TTT)

904 INVESTIGATION OF THE PHOTOPRODUCTION OF NEGATIVE PIONS FROM DEUTERIUM CLOSE TO THE THRESHOLD. M. I. Adamovich, V. G. Larionova, and S. P. Kharlamov. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 37-65(1963). (In Russian)

Emulsions were used to investigate the photoproduction of mesons(π^-) from deuterium at energies close to the threshold. The gamma rays were produced from the ac-

celeration of electrons in the Lebedeff Physical Institute synchrotron. Particles were identified visually. In all, 720 stars were identified that could be assigned to the investigated reaction $\gamma + d \rightarrow p + p + \pi^-$. The reaction was studied for photon energies ranging from the threshold to 174 Mev. The angular distribution of the mesons(π^-) for photon energies of 153 to 174 Mev was found to be isotropic indicating that meson(π^-) formation took place in an S-state. From an examination of the kinetic energies of the various particles it was concluded that the final state of the reaction is such that the nuclear interaction between the final protons is for the two particles to be in a $^1S_0$ state. The only transition that can form an S-state meson(π^-) and $^1S_0$-state protons is an E1($^1S_0$,S) transition. This means that the electric dipole absorption of the photons is responsible for the formation of mesons(π^-) up to a photon energy of 174 Mev. (TTT)

905 MULTIPLE SCATTERING OF ELECTRONS AND POSITRONS IN NITROGEN. Ian Balfour Strong. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 125p.

The momentum dependence of multiple scattering and the positron-electron differences in dependence were investigated. A low-turbulence Wilson chamber was designed, in which the scattering could take place and be photographed. Radioactive sources providing electrons and positrons simultaneously were prepared. Since the chamber was completely automatic, a large number of tracks could be recorded in a reasonable time. N gas was used as the scattering medium. The films were then examined on a specially constructed scanner-comparator. The coordinates of successive points on satisfactory tracks were measured by the comparator and automatically punched out on IBM cards. The multiple scattering, after a considerable number of corrections are applied, is found from the deviations from the estimated unscattered path. Of the tracks measured by the comparator, 4537 were used in the analysis, 2650 were of electrons and 1887 were of positrons. Best-fit curves were computed and compared with the theories of Moliere, Williams, Bothe, Goudsmit and Saunderson, and Snyder and Scott. It was concluded that the theory of Williams with the limiting angles due to H. A. Bethe best fitted the experimental results. A study of the positron-electron differences strongly suggests that the difference exists but is of the order of only a few percent. (M.P.G.)

906 THE MEAN LIFE OF THE NEUTRAL Pi-MESON. Maung Hla Shwe. Thesis, Berkeley, Calif. Univ. of California, 1963. 71p.

The proper mean life of the neutral pion was measured by a new method, which utilizes a large relativistic time dilation. Negative pions of 3.5 Bev/c were allowed to make interactions in Ilford K.5 nuclear research emulsions. From a total of 3600 interactions, 103 neutral pions were found, which decayed by the Dalitz mode $\pi^0 \rightarrow (e^+ + e^-) + \gamma$. The π^0 path lengths were accurately measurable and were automatically calculated by specially developed microscope equipment. The neutral-pion momentum spectrum was assumed to be the same as that of the secondary charged pions (which was found be multiple scattering measurements). The mean transverse momentum of secondary charged pions at all angles is 274 ± 10 Mev/c. The opening angle distribution of the electron pairs was measured and compared with extensive calculations of the expected laboratory distribution in order to evaluate the number of unobserved events. A statistical approach was used to evaluate the mean life, τ_{π^0}, of the neutral pion. The maximum likelihood estimate is $\tau_{\pi^0} = 2.0^{+0.5}_{-0.3} \times 10^{-16}$ sec. Systematic errors were carefully eliminated, and their residual effect is thought to be small. The significance of the measured π^0 mean life for various theories is reviewed. (Dissertation Abstr.)

907 NEGATIVE PION-PROTON INTERACTIONS AT 1.97 Bev/c. Frank Elias Schwamb. Thesis, Tallahassee, Fla., Florida State Univ., 1963. 120p.

Data obtained from multiple pion production in negative pion-proton interactions at incident pion momenta of 1.97 Bev/c were compared with the predictions of 3 presently existing "models" involving such pion production: the statistical model, the isobar model, and the one-pion exchange model. Of a total of 5555 total interactions photographed in a liquid-H bubble chamber, 498 four-prong events were found. The number of fitted events and partial cross sections according to reaction type were found as follows: (1) $\pi^- + p \rightarrow \pi^- + \pi^+ + p$, 199 events, 1.52 ± 0.13mb; (2) $\rightarrow \pi^- + \pi^+ + \pi^- + p + \pi^0$, 143 events, 1.11 ± 0.11mb; (3) $\rightarrow \pi^- + \pi^+ + \pi^- + \pi^+ + n$, 71 events, 0.55 ± 0.07 mb. It was found that 51 ± 5% of (1) occurs with isobar production. The production mechanism is consistent with the OPE model and apparently accounts for the lack of ρ (720 Mev) meson production. A modified version of the isobar model is needed to describe the various momentum and effective mass distributions. Reaction (2) has evidence of η (550 Mev) and ω (780 Mev) meson production in the neutral triple-pion effective mass distribution. The partial cross sections are about 80 and 170 μb, respectively. The production mechanism for ω mesons is consistent with the exchange of a scalar meson. Evidence for the ζ (550 Mev) meson appears in the neutral double-pion effective mass distribution. The partial cross section is calculated to be 78 μb in reaction (2). The combined neutral double-pion effective mass distribution for reactions (2) and (3) contains supporting evidence for the recently discovered 395 Mev pion-pion resonance. The indicated partial cross section is about 350 μb for the combined channels. Other features of the reactions are apparently consistent with the statistical model. (M.P.G.)

908 PROTON-PROTON COLLISIONS AT 3.5 Bev. Robert James Piserchio. Thesis, Tucson, Ariz., Univ. of Arizona. 1963. 76p.

Ilford G-5 emulsions were exposed to an external 3.5-Bev proton beam of the Berkeley Bevatron. A total of 1200 nuclear interactions of beam protons was located, of which 128 were identified as proton-proton collisions. Multiple scattering, blob density, range, and angle measurements were employed to determine the cross sections for elastic and inelastic interactions, as well as the identities and center-of-mass-system momenta and scattering angles of secondaries from inelastic proton-proton interactions. This analysis indicates a cross section of 8.0 ± 2.4 mb for elastic events, 24.1 ± 2.9 mb for 2-prong inelastic events, 7.9 ± 1.4 mb for 4-prong events, and 0.6 ± 0.3 mb for 6-prong events. The mean charged pion multiplicity in inelastic interactions is 1.5 ± 0.2 and corresponds to an average degree of inelasticity of 0.45 ± 0.06. Center-of-mass-system angular distributions of charged secondaries from inelastic events display a peaking for small scattering angles, which is most pronounced for protons and pions from events with low secondary multiplicity. Momentum and transverse momentum distributions of secondary protons and pions from inelastic events are presented and compared with the results at other energies. The angular distribution of elastically scattered protons is found to be in fair agreement with that predicted by a uniform optical model of radius 1.25×10^{-13} cm and opacity 0.66. The re-

sults of the experiment are also in reasonable agreement with the predictions of a statistical model that incorporates isobar production. Q values for all combinations of nucleon-nucleon and pion-pion pairs were calculated and showed a dominance of Q values less than 50 Mev. Q values for events in which one of the tracks was a low energy proton showed some evidence of a resonance with Q values of 150 Mev and higher. (Dissertation Abstr.)

909 THE TWO-NUCLEON INTERACTION. Michael J. Moravcsik, ed. Oxford Library of the Physical Sciences. Oxford, Clarendon Press, 1963. 162p. $2.90.

The experimental information on nucleon–nucleon interactions is summarized in terms of phenomenological formalisms which are based on generally accepted theoretical concepts and conservation laws. Such phenomenological analyses, in terms of potentials or phase shifts, were developed in detail, and succeed in describing the proton–proton interaction uniquely in the elastic region with good accuracy. Similar descriptions of the neutron–proton interaction are also given, although uniqueness there cannot yet be guaranteed. The fundamental theory of the two-nucleon interaction has developed along two main avenues. The older approach is in terms of pion field potential theory, in which a potential is calculated assuming that the interaction between the two nucleons is due to a pion field. The majority of these calculations used some form of weak coupling theory, that is, a scheme in which an expansion is made in terms of the number of particles present in the pion cloud responsible for the interaction. Apart from possible basic inconsistencies in field theories in general, this approach fails in a practical sense at small distances or large interaction energies where the expansion in the number of particles certainly fails to converge. At larger distances (beyond 1 fermi), however, the calculations tend to agree with each other semiquantitatively with the possible exception of the potential in the central triplet even potential. Such a calculated potential is also in fair agreement with potential derived phenomenologically from the data. The other approach to the fundamental theory is through the dispersion relations. In this the scattering amplitudes are calculated directly from integral equations which are constructed using unitarity, causality, and crossing symmetry and certain assumptions about the form of the integral kernels. This approach avoids many of the convergence difficulties of the pion field potential calculations, and in fact it might even be possible that dispersion relations could be established entirely independently of field theory, in which case the possible basic self-inconsistencies of field theory are also eliminated. On the practical side, however, dispersion relations are not more successful in calculating the two-nucleon potentials; only the long range part (corresponding to the one- and two-pion exchange processes) was calculated in any approximation. The main practical virtue of dispersion relations so far is to exhibit the necessary connection between the two-nucleon and the two-pion process. As far as the future developments are concerned, there are two schools of thought. One maintains that the dispersion relation approach is basically the right one, and that manageable calculation techniques, now completely unknown, will be found to predict from it the nucleon–nucleon interaction even at small distances or high energies. It is claimed that since strong interactions are dealt with, the theory will by necessity be complicated, and a qualitatively correct approximate prediction cannot be made from a simplified theory. The other point of view is that whether the interaction is strong or not, nature is simple if the right way of looking at it is found. Since dispersion relations do not seem to provide such a simple view, they represent an incorrect approach to strong interactions, though some of their elements may survive in the long run. Elementary particle physics, it is claimed, needs a fundamentally new idea like quantum mechanics was in atomic phenomena, which then could quickly and simply explain a whole new class of phenomena, as it was the case in the decade after 1925. (auth)

910 THE CONCEPT OF THE POSITRON. A PHILOSOPHICAL ANALYSIS. Norwood Russell Hanson, ed. New York, Cambridge University Press, 1963. 243p. $5.95.

An attempt is made to secure some philosophical points, without which features of the positron discovery would be difficult to grasp. Newton's Theory of Fits is examined as the conceptual basis of light. The historical foundation and conceptual superstructure of the wave-particle duality are set forth for appreciation of the positron hypothesis. The classical dynamical and geometrical models of fundamental particles are shown to be untenable in principle. The hole theory of the positive electron is placed into some perspective with the fact that a picture of the physical properties of the positron is impossible. The effects of the conceptual tension in quantum theory between the Correspondence Principle and the Uncertainty Principle on the understanding of the positron are discussed. The Copenhagen interpretation of quantum theory in the discovery of the positron is defended. The theoretical equivalence of wave mechanics and matrix mechanics is discussed. Theory, observation, and experiment in microphysics is disentangled, and three different discoveries of the positron and their relation are discussed. (R.E.U.)

911 RESONANCE MODEL IN NUCLEON-ANTINUCLEON ANNIHILATION. Germinal Cocho Gil. Thesis, Princeton, N. J., Princeton Univ., 1962. 92p.

The $\bar{N}N$ annihilation at rest is analyzed assuming the final state interactions are so strong that, instead of a n-particle phase space, there is actually a 2-particle phase space. Considering as particles the π, ρ, and ω "particles," and taking in account only the one-nucleon exchange diagrams, expressions are derived for the charge multiplicity distribution and for the one-pion energy spectrum. These expressions are functions of the $\bar{N}N\pi$, $\bar{N}N\rho$, and $\bar{N}N\omega$ "effective" coupling constants. These are used as parameters, which are chosen to fit the experimental charge multiplicity distribution. When these values are used in the expression for the energy spectrum, a good agreement with the experimental data is obtained, except that the model yields sharp peaks, which are not evident in the experimental data. (In the model, these peaks come from the processes $\bar{N} + N \rightarrow \pi + \rho$, $\bar{N} + N \rightarrow \pi + \omega$). The value for the ratio between the $NN\omega$ and $NN\rho$ "effective" coupling constants (~1.7) is in reasonable agreement with that obtained by Lichtenberg et al. from the pp scattering data at intermediate energy (~ 3). However, the same ratio is not obtained from the E-M nucleon form factors data, if it is assumed that the E-M nucleon structure is dominated by the ρ and ω pole terms. (Dissertation Abstr.)

912 SELF-CONSISTENT DETERMINATION OF THE NUCLEON MASS AND RELATED QUANTITIES. Ernest Stephen Abers. Thesis, Berkeley, Calif., Univ. of California, 1963. 92p.

It has been suggested that all the observable properties of strongly interacting systems can be determined self-consistently, if there do not exist any elementary particles in the conventional sense. This conjecture is applied to

the nucleon mass and the pion-nucleon coupling constant, which are calculated under the assumption that the nucleon is composite, and that its existence is a consequence of the same forces that produce the pion-nucleon resonances. A self-consistent calculation is possible because the nucleon and the 3-3 resonance are principally responsible for the forces that produce each other, providing an example of a "bootstrap" or self-supporting mechanism. The N/D method is used for computations. The introduction of a cutoff is unavoidable, so that there is some ambiguity in the quantitative results; but a large range of cutoff values predicts the same orders of magnitude as are observed experimentally. It is shown qualitatively that the self-consistent method not only predicts the nucleon and the 3-3 resonance, but excludes many other combinations that are not observed. Finally the method is extended to the determination of the properties of the Σ and the K^*. (Dissertation Abstr.)

913 SEARCH FOR CHARGED PARTICLES WITH REST MASS BETWEEN THAT OF THE ELECTRON AND MU-MESON. David Hand Coward. Thesis, Stanford, Calif., Stanford Univ., 1963. 97p.

An attempt was made to produce charged particles with rest mass between that of the electron and μ meson (hereafter called submuons) by electromagnetic pair production from C nuclei. The incident photon beam was obtained by bombarding a thick C block with an 800-Mev electron beam. The same block served as the target for the production process. Only one member of the produced pair was to be observed. The momentum of the secondary particles (300 Mev/c) was determined by a zero-dispersion, double-focusing magnetic spectrometer. The particles traversing the spectrometer were detected by a 6-counter telescope, in which the counters were separated by various thicknesses of lead. The signals from the counters were put in coincidence in a 6-channel fast-resolution coincidence circuit. The telescope was sensitive to submuons with rest masses between 175 and 10 electron masses. The expected counting rates were calculated using the Bethe-Heitler and Pauli-Weisskopf formulas for spin $\frac{1}{2}$ and spin 0 submuons, respectively. An integration over the variables of the unobserved member of the pair, and thus over the momentum transfer to the C nucleus was performed. The nucleus was treated by a sum rule calculation to take into account both the finite nuclear size and the elastic and inelastic contributions to the cross section. The resulting cross sections were multiplied by the total photon spectrum and the results integrated over the available photon energy. The total photon spectrum included both the real photon spectrum from electron bremsstrahlung in the C target and the virtual photon spectrum associated with the electrons themselves. The expected counting rates varied from 70 to 12,500 counts per 10^{17} incident electrons for spin $\frac{1}{2}$ submuons with rest masses between 175 and 25 electron masses and half lives in the microsecond region or longer. The similar rates for spin 0 submuons were 10 to 2870 counts. Since only 4.10 ± 2.05 counts per 10^{17} incident electrons were observed, it seems highly unlikely that particles with rest mass between that of the electron and mu-meson exist. (M.P.G.)

914 PION-PROTON COLLISIONS AT 3.5 Bev/C. Richard Lee Childers. Thesis, Knoxville, Tenn., Univ. of Tennessee, 1962. 106p.

Fundamental collisions of energetic pions with protons were sought in a stack of Ilford K5 emulsions exposed to a 3.5-Bev/c π^- beam. Multiple scattering, angle, and ionization measurements were made on a sample of 106 π^- + p events that had charged secondaries. The measurements were made on a Brower scattering microscope. Kinematic criteria were used to separate the various types of events. The elastic to inelastic ratio of 1:3.9 indicates an interaction distance of $(1.05 \pm 0.10) \times 10^{-13}$ cm. The inelastic events show a strong backward peaking in the c.m. angular distribution of the protons. The fast pions from the inelastic events ($\beta \geq .9$) are mostly in the forward direction, while the slower pions are more or less symmetrically distributed about 90° in the c.m. The partial cross sections are given approximately by σ (elastic) = 5.8 mb, σ (two-prong inelastic) = 17.6 mb, σ (four-prong inelastic) = 2.9 mb, and σ (neutral secondaries) = 2.3 mb. A multiplicity of 2 or more is indicated by the missing mass distribution. The lack of 6-prong stars implies an upper limit of 3 for the multiplicity. It is estimated that there is an average of one π^0 produced per collision. A large fraction of the available energy seems to be carried off by neutrals. The average anelasticity is calculated to be 0.48 for all types of events. (Dissertation Abstr.)

915 EXPERIMENTAL TRAJECTORY ANALYSIS OF CHARGED PARTICLES IN A CUSPED GEOMETRY. James Sinnis. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1963. 56p.

Electrons are injected axially from an external source into a cusp field. For particles to be transmitted through the cusp, they must be injected inside a "loss disk" of radius $\rho_{critical} = (mv)/(q\beta_0^B)$. At larger values of the injection radius, the depth of penetration beyond the median plane is measured and is in agreement with the maximum penetration depth predicted by the theory. The question of trapping is investigated, and no long-time confinement is obtained. The maximum number of reflections observed inside the cusp region is five. (Dissertation Abstr.)

916 ON THE USE OF FIELD THEORETICAL MODELS IN STRONG INTERACTION PHYSICS. Sergio Fubini (Università, Turin and CERN, Geneva). 16p. (CONF-122-17)

From International Conference on Nucleon Structure, Stanford, Calif., June 1963.

The effects of the short-range behavior in potential scattering upon the asymptotic behavior of the strong-interaction scattering amplitude and upon the validity of the methods of solution are discussed, using models. In particular, it is found that for certain singular potentials, the bound-state problem cannot be solved by a plane-wave expansion. For these singular potentials, an integral equation must be set up by means of an expansion in terms of eigenfunctions having the correct behavior at small distances. The study makes use of both the Schroedinger and Bethe-Salpeter equations. (T.F.H.)

Field Theory and Quantum Mechanics

917 (PAN-427/II) FRAUNHOFER DIFFRACTION AT 0°K OF FIELD EMITTED ELECTRONS PASSING THROUGH AN INFINITE SLIT. A. Czachor (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 12p.

A general wave function for electrons being emitted under the influence of an electrostatic field is applied to the special case of emission by a very thin slit of infinite length. Using this, the resolution of the field emission microscope is estimated. (auth)

918 THE HELLMANN-FEYNMAN THEOREM IN THE VARIATIONAL METHOD. R. Gáspár (Kossuth Lajos Univ., Debrecen, Hungary and Research Group for Theoretical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 16: 165-7(1963).

The difference is found between the exact and the calculated $(\bar{1}/r)$ using the variational method. This difference is very small and approaches zero rapidly with increasing atomic number. The difference for the hydrogen ion is $0.00328\ a_0^{-1}$, and for the helium atom is $0.00082\ a_0^{-1}$. (R.E.U.)

919 THE HELLMANN-FEYNMAN THEOREM AND THE CORRELATION ENERGY. R. Gáspár (Kossuth Lajos Univ., Debrecen, Hungary and Research Group for Theoretical Physics, Hungarian Academy of Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 16: 169-72(1963).

The correlation energy is found. This is defined as the difference of the exact (the relativistic corrections subtracted) energy and the Hartree-Fock energy. The correlation energy dependence on any parameter in the Hamiltonian is found. Correlation energies of the isoelectronic series of He are given. (R.E.U.)

920 REMARK ON THE EIGENVECTORS OF ANGULAR MOMENTUM OPERATORS. H. A. Buchdahl (Australian National Univ., Canberra). Am. J. Phys., 31: 829-34 (Nov. 1963).

Elementary treatments of a single angular momentum having components J_k (k = 1, 2, 3) usually go as far as discussions of the spectra of these operators and the derivations of their standard, i.e., J^2, J_3-diagonal, representatives. On the other hand, the standard representatives of their eigenvectors are not usually obtained, leaving J_3 aside, for which the problem is trivial. In fact, this part of the theory is most often dealt with only after a lengthy excursion into the theory of matrix representations. The representatives in question are obtained here by means of essentially elementary arguments. Once these representatives are known, the standard representative of the unitary operator U which generates the state vector of a system after it has undergone a rotation R from the state vector prior to the rotation is deduced; this representative comprises just the familiar matrix representations of the rotation group. The relevance of harmonic oscillator theory to this problem is briefly considered. (auth)

921 ON THE GREEN'S FUNCTION OF GAUGE-INDEPENDENT THEORY OF QUANTUM ELECTRODYNAMICS. A. Q. Sarker (Univ. of Brimingham, Eng.). Ann. Phys. (N. Y.), 24: 19-36(Oct. 1963).

The Green's functions of conventional theories of quantum electrodynamics with potentials determined within arbitrary gauges are derived from the gauge-independent formalism, recently proposed by Mandelstam. (auth)

922 THE THEORY OF A GENERAL QUANTUM SYSTEM INTERACTING WITH A LINEAR DISSIPATIVE SYSTEM. R. P. Feynman (California Inst. of Tech., Pasadena) and F. L. Vernon, Jr. Ann. Phys. (N. Y.), 24: 118-73(Oct. 1963).

A formalism was developed, using Feynman's space-time formulation of nonrelativistic quantum mechanics whereby the behavior of a system of interest, which is coupled to other external quantum systems, may be calculated in terms of its own variables only. It is shown that the effect of the external systems in such a formalism can always be included in a general class of functionals (influence functionals) of the coordinates of the system only. The properties of influence functionals for general systems are examined. Then, specific forms of influence functionals representing the effect of definite and random classical forces, linear dissipative systems at finite temperatures, and combinations of these are analyzed in detail. The linear system analysis is first done for perfectly linear systems composed of combinations of harmonic oscillators, loss being introduced by continuous distributions of oscillators. Then approximately linear systems and restrictions necessary for the linear behavior are considered. Influence functionals for all linear systems are shown to have the same form in terms of their classical response functions. In addition, a fluctuation-dissipation theorem is derived relating temperature and dissipation of the linear system to a fluctuating classical potential acting on the system of interest that reduces to the Nyquist-Johnson relation for noise in the case of electric circuits. Sample calculations of transition probabilities for the spontaneous emission of an atom in free space and in a cavity are made. A theorem is proved showing that within the requirements of linearity all sources of noise or quantum fluctuation introduced by maser-type amplification devices are accounted for by a classical calculation of the characteristics of the maser. (auth)

923 A DYNAMICAL ORIGIN FOR THE ELECTROMAGNETIC FIELD. J. D. Bjorken (CERN, Geneva). Ann. Phys. (N. Y.), 24: 174-87(Oct. 1963).

The electrodynamic interaction is considered as originating from a short-range interaction between currents instead of the long-range starting point of quantum electrodynamics. The long-range character of the effective interaction is obtained from the short range by setting the ambiguous quadratically divergent integral for the photon mass equal to 1 instead of zero. This possibility is associated, due to gauge invariance, with the existence of a charge asymmetry in the vacuum, the origin of which is not well understood. (auth)

924 ASYMPTOTIC BEHAVIOR OF THE WAVE FUNCTION OF A SYSTEM OF NEUTRAL AND CHARGED PARTICLES. R. K. Peterkop (Inst. of Physics, Academy of Sciences, Latvian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1012-17(Aug. 1963). (In Russian)

Ionization problems of atoms and ions usually involve systems that after a collision contain 3 or more free, divergent particles. In order to be able to solve these problems, the asymptotic behavior at infinity of the wave function which determines the collision, must be known. A nonrelativistic reaction channel was considered as an example of a generalized case; it was assumed to contain N composite or elementary diverging particles, some or all of which may be charged. Considering the center of inertia, the problem leads to the determination of the motion of N-1 particles, which may so chosen that the vectors connecting the actual particles become linear or homogeneous functions of the radius vectors. The convergence of the integral expression defining the amplitude of the excitation and ionization function may be determined from the asymptotic curve of the whole wave function. A similar problem, involving the collision of electrons with H atoms, was previously studied (Opt. i Spektroskopiya, 13: 153(1962)) using Green's theorem of space integrals; it was found that an asymptotic expression may be applied. The derived formulas may be also used for analyzing certain portions of the continuous spectrum of the wave function. (TTT)

925 APPLICATION OF A GENERAL METHOD FOR DEVELOPING TRIAL WAVE FUNCTIONS. V. D. Kament-

skii and V. T. Murav'ev (Moscow Textile Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1027-9(Aug. 1963). (In Russian)

Methods based on experimental wave functions are extensively used for the calculation of the effective collision cross section of slow electron-atom interactions. The accuracy of these methods was closely examined. G. Kantariya (Trudy Tbilissk. Univ., 62: 119(1957)) used experimental functions in the quantum theory of collision; he recommended the use of combinations of certain members derived from the wave function. It was shown by a more detailed analysis that the results of such calculations are not too reliable. Solution of the functions related to scattering without considering the energy exchange, requires setting up a large number of differential equations which can be integrated only numerically. Improvements were made in the trial functions (Dissertation, Leningrad University, 1961); on the basis of those findings, trial function calculations were carried out on the elastic scattering of slow s-electrons on H atoms, without specifically considering the energy exchange and the polarization. The method used was found to yield very accurate results. The functions derived are suitable for numerical computation. (TTT)

926 A LATTICE OF VON NEUMANN ALGEBRAS ASSOCIATED WITH THE QUANTUM THEORY OF A FREE BOSE FIELD. Huzihiro Araki (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 4: 1343-62(Nov. 1963).

Von Neumann algebras associated with the normal representation of canonical commutation relations are studied. Corresponding to each subspace of a real Hilbert space (test function space), a von Neumann algebra on another complex Hilbert space (the Fock space) is defined. This correspondence is proved to be an isomorphism between a certain complemented lattice of subspaces and that of the von Neumann algebras. This result has an application to the duality theorem in the theory of a free scalar field. A necessary and sufficient condition on a subspace, in order that the corresponding von Neumann algebra is of type I, is obtained. (auth)

927 METHOD FOR CONSTRUCTION OF UNITARY OPERATORS IN QUANTUM FIELD THEORY. Paul H. Moravek and David W. Joseph (Naval Research Lab., Washington, D. C.). J. Math. Phys. (N. Y.), 4: 1363-6 (Nov. 1963).

A method for the construction of explicit representations of unitary Hilbert-space operators in the particle-number representation is presented and illustrated by application to several examples. (auth)

928 FUNDAMENTAL PROPERTIES OF PERTURBATION-THEORETICAL INTEGRAL REPRESENTATIONS. [PART] II. Noboru Nakanishi (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.), 4: 1385-92 (Nov. 1963).

It is investigated, apart from the perturbation-theoretical basis, under what conditions the perturbation-theoretical integral representations can be derived, and two theorems are given concerning this problem. The asymptotic behavior of the weight function in the integral representation is investigated in perturbation theory. It is proved that the weight function vanishes at infinity for an infinite sum over certain graphs which are much more general than the ladderlike graphs. This result gives the analyticity in the right half-plane of complex angular momentum. (auth)

929 SINGULARITIES OF REGGE TRAJECTORIES AND ASYMPTOTES TO LANDAU CURVES. J. C. Polkinghorne (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 4: 1393-5(Nov. 1963).

A new class of singularities associated with the trajectories and residues of particular Regge poles is investigated. It is shown that the singularities are associated with properties of asymptotes to Landau curves. One of the singularities corresponds to the singularity of the Regge amplitude discovered recently by Islam, Landshoff, and Taylor. The only singularities affecting physical asymptotic behavior correspond to diagrams which have all three Mandelstam spectral functions. (auth)

930 HIGH-ENERGY BEHAVIOR IN PERTURBATION THEORY. [PART] II. J. C. Polkinghorne (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 4: 1396-1400(Nov. 1963).

Contributions to the asymptotic behavior of Feynman integrals, which correspond to pinches in the interior of the hypercontour of integration, are evaluated. It is shown that they give the Gribov-Pomeranchuk phenomenon and Regge cuts. A set of diagrams is investigated which gives a Regge cut on the physical sheet. (auth)

931 BEHAVIOR OF THE SCATTERING AMPLITUDE FOR LARGE ANGULAR MOMENTUM. A. O. Barut and J. Dilley (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 4: 1401-8(Nov. 1963).

Langer's theory on the asymptotic behavior of the solutions of differential equations is applied to angular momentum, giving stronger results than were possible hitherto by Born approximation. It is shown that, for potentials $V(r)$ analytic in the right-hand r plane satisfying $|r^2V(r)| < \infty$ at $r = 0$ and $|r| = \infty$, the phase shift has the asymptotic form ($\lambda = l + \frac{1}{2}$)

$$\delta \underset{\lambda\to\infty}{\to} -(2\lambda^{1/2})^{1/2}\frac{V(\lambda/k)}{2k^2} - \lambda^{-1}\int_{\lambda/k+\lambda^{-1/3}/k}^{\infty}\frac{V(r)r\,dr}{(k^2r^2/\lambda^2-1)^{1/2}}, \quad \mathrm{Re}\lambda > 0,$$

in the λ plane and for all complex k. Consequently, all Regge trajectories are bounded for analytic potentials; there are no poles for $|\lambda| \to \infty$ in the right-half λ plane, stronger limits can be given for the feasibility of the Watson-Sommerfeld transformation. The pathological behavior of the cut off potentials (e.g., square-well) is attributed to the nonanalyticity of the potential. (auth)

932 ASYMPTOTIC BEHAVIOR OF SCHRÖDINGER SCATTERING AMPLITUDES. L. Sartori (Rutgers Univ., New Brunswick, N. J.). J. Math. Phys. (N. Y.), 4: 1408-14(Nov. 1963).

The behavior of the S-wave scattering amplitude for large k is studied for potentials which vanish at infinity faster than any exponential, but are not cut off. The asymptotic behavior is very sensitive to the shape of the potential tail. If the potential decreases very rapidly, the growth of the Jost function resembles that with a cut-off potential. If V(r) decreases only slightly more rapidly than an exponential, then f(k) exhibits a very rapid growth in the vicinity of the positive imaginary axis. In this case also the zeros of f(k) become very dense and are concentrated near the positive imaginary axis. (auth)

933 COUPLED SCHRÖDINGER EQUATIONS AND STATISTICAL BOUNDARY CONDITIONS. C. Dullemond (Univ. of Washington, Seattle). J. Math. Phys. (N. Y.), 4: 1415-32(Nov. 1963). (TID-19004)

The possibility of introducing distribution functions for the phase of a radial wavefunction at a boundary is studied for the case of elastic scattering. The properties of a simple class of distribution functions are discussed. The results are generalized to the solutions of an arbitrary number of coupled Schrödinger equations which satisfy time-reversal invariance, provided there are no closed channels. (auth)

934 CANONICAL VARIABLES FOR THE INTERACTING GRAVITATIONAL AND DIRAC FIELDS. T. W. B. Kibble (Imperial Coll. of Science and Tech., London). J. Math. Phys. (N. Y.), 4: 1433-7(Nov. 1963).

The problem of reducing the Lagrangian for the interacting gravitational and Dirac fields to canonical form is discussed, using the vierbein formalism. The arbitrary gauge variables corresponding to local Lorentz transformations of the vierbein are removed by imposing Schwinger's time-gauge condition, and a further condition that the spatial part of the vierbein be symmetric. It is shown that in this gauge the Lagrangian can be expressed in a canonical form involving essentially the same gravitational-field variables as in the absence of matter, and that the generators of spatial translations and rotations have the expected form. (auth)

935 CLUSTER DEVELOPMENT IN AN N-BODY PROBLEM. F. Y. Wu (Washington Univ., St. Louis). J. Math. Phys. (N. Y.), 4: 1438-43(Nov. 1963).

The procedure for generating useful cluster development in problems dealing with the Jastrow wavefunction, as proposed by Wu and Feenberg (NSA 17: 748), is discussed in detail. The existence of the expansion is proved to all orders; also a simple rule is given for computing the expansion coefficients. The result can be considered as a generalization of the Ursell-Mayer formulas. (auth)

936 STRICT LOCALIZATION. A. L. Licht (Naval Ordnance Lab., Silver Spring, Md. and Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 4: 1443-?(Nov. 1963).

A complete characterization for a general quantum field theory is given of the strictly localized states introduced by J. Knight (NSA 15: 24468). It is shown that each such state can be generated from the vacuum by a partially isometric operator. Necessary and sufficient conditions are given for the superposition of such states to be also strictly localized. Finally, it is shown that there is a connection between the von Neumann type of the ring generated by the field operator in a finite region and the possibility of constructing strictly localized states. (auth)

DENSITY OF BOSONS IN PHASE-SPACE AND THE TRANSITION FROM PARTICLE TO WAVE BEHAVIOR. P. Gordon (Brandeis Univ., Waltham, Mass.). Nuovo Cimento (10), 29: 935-46(Aug. 16, 1963).

An attempt is made to put various well known phenomena in boson systems on a common basis by considering their behavior as the transition from particle to wave characteristics as the density in phase-space increases. An operational definition is given for the wavelike behavior of a system. It is shown that this equals the average number of bosons per unit cell of phase-space. Black body fluctuations, ordinary interference, and the fluctuations in a beam of light are considered. Various related topics are discussed. (auth)

938 NUMERICAL CALCULATIONS AND APPLICATIONS CONCERNING THE ELIMINATION OF "GHOST POLES" IN PROPAGATORS. G. Rasche, N. Straumann, and K. Weiss (Universität, Zurich). Nuovo Cimento (10), 29: 962-6(Aug. 16, 1963).

The Güttinger-Swieca method of eliminating ghost poles in propagators is performed numerically for the Lee model and is applied to the Lamb-shift in quantum electrodynamics. (auth)

939 TABLES OF PARAMETERS OF ANALYTIC WAVE FUNCTIONS OF ATOMS AND IONS. [PART] II. I. V. Kirillova, M. G. Veselov, and V. F. Brattsev. Opt. Spectr. (USSR) (English Transl.),15: 1-3(July 1963).

The parameters of hydrogen-like functions and term energies are computed for isoelectronic configurations of the form $1s^2 2s^k 2p^n$. Semiempirical energy formulas are derived for certain states. (auth)

940 QUANTUM THEORY OF KINETIC EQUATIONS FOR ELECTRONS IN PHONON FIELDS. Petros N. Argyres (Massachusetts Inst. of Tech., Lexington). Phys. Rev., 132: 1527-43(Nov. 15, 1963).

A method is presented which yields a kinetic equation for the time development of the one-electron density matrix for dynamically independent electrons in phonon and other arbitrary static fields of force under the influence of a weak but otherwise general external dynamical disturbance. The exclusion principle, the finiteness of the phonon energies, and the quantum mechanical nature of the processes involved are taken into account rigorously. The effects of the electron-phonon interaction are described only in the Born approximation. A kinetic equation for the steady state is also derived in an arbitrary one-electron representation. An iterative solution of the kinetic equation is discussed and the power absorption due to direct and indirect transitions is derived from the general kinetic equation. The case of a uniform but oscillating electric field is considered in detail for free, Landau, and Bloch electrons, for which special kinetic equations are derived. A local density matrix, useful in the calculation of space-varying densities of various physical observables, is introduced and a kinetic equation for it is obtained from the general theory. Applications of it are made to the case of free and Landau electrons for disturbances of arbitrary space-time variation. The applicability of the method to more general situations is indicated. (auth)

941 IMPROVEMENT OF THE BORN SERIES AT LOW ENERGY. Marcel Wellner (Indiana Univ., Bloomington). Phys. Rev., 132: 1848-53(Nov. 15, 1963).

The Born series for a quantum-mechanical Green function is studied. A prescription is given for making best use of the information contained in the first few terms of that series, and, in particular, for calculating bound states or resonances from them. This prescription is based on heuristic convergence arguments whose formal steps are somewhat reminiscent of renormalization group methods. These considerations may be applied to potential scattering as well as to quantum field theory. They are expected to be valid for low-energy phenomena and finite-range forces. The prescription is tested, using only the first two Born terms, in the case of a nonrelativistic particle moving in a Yukawa potential: For well depths producing a single shallow bound state, the usual effective-range results are closely reproduced, and, in some ways, improved upon. (auth)

942 FORMULATION AND NUMERICAL SOLUTION OF A SET OF DYNAMICAL EQUATIONS FOR THE REGGE POLE PARAMETERS. Hung Cheng and David Sharp (California Inst. of Tech., Pasadena). Phys. Rev., 132: 1854-66 (Nov. 15, 1963).

The principles of analyticity and unitarity were shown previously to lead to a set of coupled nonlinear integral equations for the Regge pole parameters. It is demonstrated, for both boson and fermion trajectories, that these equations can be written in a very simple form which makes many of their mathematical properties transparent and permits their numerical solution by iteration. Their numerical solution is carried out in a number of interest-

ing cases. Because those equations are approximate, the equations were first solved in the potential-theory case, where the results could be compared with those obtained from the Schrödinger equation. The agreement in most cases is good. The determination of the Regge pole parameters which describe relativistic $\pi\pi$ scattering at high energies is discussed. Neglecting the inelastic contributions, the Pomeranchuk trajectory, the ρ-meson trajectory, and the second vacuum trajectory P′ are calculated. One notable result of this set of calculations is that the function Re $\alpha(t)$ for the Pomeranchuk trajectory, as determined by the equations, agrees well with the results obtained by Foley from an analysis of the π^-p angular distributions in the range -0.8 (Bev/c)$^2 < t < -0.2$ (Bev/c)^2. No spin-2 resonance is found to lie on this trajectory. As for the ρ trajectory, it is found that $\alpha_\rho(t)$, -0.8 (Bev/c)$^2 < t \leq 0$, is larger than 0.9 for a wide range of input parameters. The width of the ρ resonance, as determined from these equations, is several times larger than the experimental width. This probably means that inelastic contributions must be included to obtain a correct value for the width. Various problems which remain to be investigated are outlined. (auth)

943 GRAVITATIONAL FIELD OF A SPINNING MASS AS AN EXAMPLE OF ALGEBRAICALLY SPECIAL METRICS. Roy P. Kerr (Univ. of Texas, Austin and Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev. Letters, 11: 237-8(Sept. 1, 1963).

Algebraically special solutions of Einstein's empty-space field equations that are characterized by the existence of a geodesic and shear-free ray congruence are considered. A class of solutions is presented for which the congruence is diverging and is not necessarily hypersurface orthogonal. (C.E.S.)

944 QUANTUM THEORY OF THE ENERGY SPECTRUM OF SUPERFLUIDS. Henry Woodrow Jackson. Thesis, St. Louis, Washington Univ., 1962. 202p.

An explicit formula for the energy eigenvalues for the low states of a superfluid is developed in a "free phonon" approximation; this formula exhibits clearly the quasi-particle nature of the excited states. Initially, a certain basis of correlated wave functions is assumed and used to construct an orthonormal basis. In the representation of the latter basis, the Hamiltonian has a particularly simple form, which is then diagonalized by a Bogoliubov-type transformation. The method and results can be applied to a system of strongly interacting particles, such as a real system of He-4, as well as to a model system of weakly interacting particles. The energy formula yields the results obtained by Feynman and by Bogoliubov as special cases. Next the "free phonon" results are taken as a zeroth-order approximation and used to calculate the correction to the dispersion curve for elementary excitations in the approximation of the Brillouin-Wigner second-order energy formula. The computed elementary energy spectrum is compared with the dispersion curve constructed from the single inelastic scattering of neutrons by Henshaw and Woods, and with the theoretical curve obtained from a variational calculation by Feynman and Cohen. Approximations involved in the present calculation are discussed, and a discrepancy between theoretical and experimental energy values for excitations with small momentum is studied. A method for examining the stability of elementary excitations corresponding to both experimental and theoretical dispersion curves is presented and applied to the curves mentioned above. Finally criteria are developed which indicate the accuracy of approximations to the 3-particle distribution function generated by the ground state of a quantum fluid. One criterion is applied to the Kirkwood superposition form for a system of He-4 in order to study the errors involved in the approximation; a related criterion is used to investigate the accuracy of approximations occurring in the second-order perturbation calculation described above. (Dissertation Abstr.)

Geophysics

945 (NASA-TN-2096) THE EFFECT OF AURORAL BREMSSTRAHLUNG ON THE LOWER IONOSPHERE. A. C. Aikin and E. J. Maier (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). July 8, 1963. 9p.

Ionization of the lower ionosphere by electrons from a type I aurora is discussed. The primary electrons produce ionization in the altitude range where, in quiet conditions, there is normally no ionization at night, but where the ionization during the day results from solar Lyman α and x-ray radiation. The bremsstrahlung resulting from the assumed flux of auroral electrons produces significant ionization at low altitudes (50–70 km) where cosmic rays are normally the only source of ionization. For certain values of the relevant parameters, predicted electron and ion densities, are given for comparison with the charged particle profiles calculated for the case of no auroral flux. (auth)

946 ON THE MOTION OF CHARGED PARTICLES IN THE GEOMAGNETIC FIELD. Ernest C. Ray (Goddard Space Flight Center, Greenbelt, Md.). Ann. Phys. (N. Y.), 24: 1-18(Oct. 1963).

An approximate first integral of the equations of motion of a charged particle in a static magnetic field is constructed. The integral is analogous to the Størmer integral, but it is not required that the field have axial symmetry in order for the integral to be exact. The integral reduces to that of Størmer when the field does possess axial symmetry. It is used to obtain results concerning trapped particles and cosmic rays previously derived using a variety of techniques. The new technique can readily be extended to cover situations not previously tractable. (auth)

947 RECOVERY TIMES OF GEOMAGNETIC STORMS. R. P. Kane (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 29: 826-40(Aug. 16, 1963).

Using the hourly values of the horizontal component of geomagnetic field at Alibag, India, the recovery times of several geomagnetic storms occurring during the period 1947-59 are evaluated. Relation between average recovery time and sunspot activity is studied. Rough parallelism is observed, however, recovery characteristics are found to be very complex on several occasions and vary widely from storm to storm even in the same year. Theoretical implications of these peculiarities are discussed. (auth)

948 ON THE INNER VAN ALLEN ZONE OF THE EARTH. G. Pizzella (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 29: 867-82(Aug. 16, 1963).

A description of the inner Van Allen zone in terms of McIlwain's coordinates is given. Exponential spectra for electrons and protons are shown to be the most suitable for expressing the results of various experiments. At $L = 1.2$ and at the geomagnetic equator there are 10^4 exp [–E/160 kev] electrons/(cm^2 s sr kev) perpendicular to the field lines, and 23 exp [–E/120 Mev] protons/(cm^2 s Mev). The time variations detected by a Geiger counter in Explorer VII, at the magnetic shell with $L > 1.5$ are

ascribed to electrons. For $L \leq 1.5$ a fractional increase of 2.3 occurs during an 11 months time interval but the inner belt geometry is shown to remain unchanged with time. Therefore it is suggested that the same source which generates the trapped particles is also responsible for the time variation. (auth)

949 A STUDY OF X-RAYS AT HIGH ALTITUDES IN THE AURORAL ZONE AND RELATED GEOPHYSICAL PHENOMENA. Clifford Donald Anger. Thesis, Berkeley, Calif., Univ. of California, 1963. 165p.

A series of instrumented balloon flights was carried out at College, Alaska in which correlations of auroral-zone x-ray bursts with "auroral" ionospheric radio-wave absorption events and geomagnetic field variations were studied. X-rays were detected by Geiger counters approximately 10% of the time. There was a pronounced tendency for the events to occur in the late night and early morning hours except during times of magnetic storms, when they occurred throughout the day. The average electron-energy flux at the top of the atmosphere during the period of these flights was estimated to be roughly 10^{11} ev/cm^2 sec. Ionospheric radio-wave absorption, as measured by the College riometer, and the x-ray events showed an obvious, and in some cases detailed, correspondence. The relationship between the x-ray events and geomagnetic disturbance was of a more general nature. X rays were observed at the times of positive and negative geomagnetic bays and quite extensively during geomagnetic storms. Sometimes the bursts were closely related to magnetic field changes, and at other times they were not. The x-ray counting rate at balloon altitudes was calculated for various electron-energy distributions using a simplified model of the Compton scattering process. Consideration was given to the quantitative relationship between radio-wave absorption and the x-ray flux. The results indicate that direct ionization by the same energetic electrons which produce the observed x rays is responsible for most of the ionospheric radio wave absorption which accompanies these events, and that in most cases, the electrons bring in enough energy to produce a visible aurora and could be the cause of certain auroral forms. (M.P.G.)

950 THE EFFECT OF DIFFUSION ON THE EQUILIBRIUM ELECTRON DENSITY DISTRIBUTION IN THE F REGION NEAR THE MAGNETIC EQUATOR. Richard Aran Goldberg. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 83p.

On the basis that electrons are constrained to move along the lines of force of the earth's magnetic field, and that the primary forces acting are due to gravity and pressure gradients, a 2-dimensional partial differential equation is derived for the equilibrium electron density distribution around the magnetic equator in an isothermal F region. A solution is developed in the form of a power series in magnetic latitude. By using a Chapman-like profile at the equator as a boundary condition, it is shown that the solution exhibits the major features of the well-known geomagnetic anomaly as observed at the equinoxes. The solution also predicts the electron density distribution above the F2 electron peak, where there are presently no observations as a function of magnetic latitude. Finally, the effects of varying sunspot number is examined. It is suggested that there are additional perturbations, not included in this theory, which give rise to the asymmetries observed at other seasons, but these are not responsible for the main effects. (Dissertation Abstr.)

951 A STUDY OF AURORAL ZONE X-RAYS AND THEIR RELATION TO GEOMAGNETIC BAYS AND MICROPULSATIONS. David Paul Marsh. Thesis, Berkeley, Calif., Univ. of California, 1962. 158p.

A series of high-altitude balloon flights was made in the auroral zone to investigate the relationship between auroral zone x rays and geomagnetic disturbances. The detectors used in these flights consisted of thin-walled Geiger counters, having different sensitivities to x rays by virtue of their cathode construction, and a Geiger counter telescope. The counting rates were compared with geomagnetic records made at the College Observatory of the U. S. Coast and Geodetic Survey. From a total of 9 balloon flights, covering 134 hrs at altitudes of approximately 30 km, x rays were detected over a period of 26 hrs. It was found that a relationship existed between the presence of x rays at high altitude and negative bays in the horizontal component of the geomagnetic field. Assuming that the ionospheric currents responsible for the magnetic disturbances could be approximated by a line current flowing at an altitude of 100 km, it was found that x rays were observed consistently when the center of the current system came close to or crossed the zenith of the balloon instrument and the magnetic observatory. A comparison of x ray data with observations of geomagnetic micropulsations showed that, while the 2 phenomena may have a common cause, no firm relationship could be established. (Dissertation Abstr.)

Low Temperature Physics

952 (ANL-SBC-1) INITIAL SUPERCONDUCTOR EXPERIMENTS. T. H. Fields (Argonne National Lab., Ill.). Aug. 10, 1962. Contract W-31-109-eng-38. 7p.

Superconducting to normal transitions involving superconducting (Nb–Zr wire)—normal joints were investigated. Heating damage, current-field and resistance-temperature relations, quench currents, normal front velocity, and transitions with slow and fast currents in the wire were examined. (D.C.W.)

953 (CONF-301-3) TYPE II SUPERCONDUCTIVITY. T. G. Berlincourt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 12, 1963. Contract AT-11-1-GEN-8. 27p.

From International Conference on the Science of Superconductivity, Hamilton, New York, Aug. 1963.

The developments that led to the identification, experimental characterization, and theoretical understanding of type-II behavior are reviewed. Recent advances are discussed with reference to magnetic, thermal, and tunneling experiments; and the implications of these findings relative to the nature of very-high-field superconductors are explored. Size effects are also briefly considered. (60 references) (auth)

954 (NP-13274(p.40-6)) HIGH MAGNETIC FIELD SUPERCONDUCTORS. C. B. Satterthwaite, J. O. Kopplin, W. C. Leung, M. Rayl, R. Ries, and R. Klingbiel (Illinois. Univ., Urbana. Coordinated Science Lab.).

Magnetization measurements on a vanadium single crystal indicated a gradual flux penetration with increasing magnetic field. Techniques and apparatus for growing Nb_3Sn single crystals were studied and developed. Also, a variety of type II superconductor samples were prepared, and a vibrating-sample magnetometer for type II superconductivity measurements was constructed and tested with pure tin. Experimental apparatus for studying critical currents and for measuring resistance at currents above the critical current was constructed. (D.C.W.)

955 PATTERNS OF SUPERCONDUCTIVITY. K. Mendelssohn (Oxford Univ.). Cryogenics, 3: 129-40 (Sept. 1963).

The development of relevant ideas in superconductivity on the basis of observed effects is traced, and a number of anomalous features are defined. Fifty-five references are cited. (C.E.S.)

956 THE NATURE OF THE SURFACE LOSSES OF SUPERCONDUCTORS AT LOW FREQUENCIES. T. A. Buchhold (General Electric Co., Schenectady, N. Y.). Cryogenics, 3: 141-9(Sept. 1963).

A very sensitive measuring technique for determining the flux penetration due to surface losses of superconductors is described. Results obtained in the frequency region 25–1000 c support the concept that the losses are hysteresis losses caused by flux trapping. Surface stresses and changes in the chemical and physical history of a given material influence the losses. (C.E.S.)

957 BEAMS OF HELIUM ATOMS AT TEMPERATURES BELOW 0.5°K. D. T. Meyer, H. Meyer, W. Hallidy, and C. F. Kellers (Duke Univ., Durham, N. C.). Cryogenics, 3: 150-5(Sept. 1963).

A cryostat containing an ellipsoidal cavity was used to produce He^3 and He^4 atomic beams. It was shown that at temperatures below 0.5°K the beams of atoms can be emitted from a heater, reflected from a wall, and detected by a receiver in the elliposid. The beam velocity was dependent on the input energy. Several observations were difficult to analyze because of the large number of unknown parameters. (C.E.S.)

958 A 101,000 GAUSS NIOBIUM–TIN SUPERCONDUCTING SOLENOID. D. L. Martin, M. G. Benz, C. A. Bruch, and C. H. Rosner (General Electric Research Lab., Schenectady, N. Y.). Cryogenics, 3: 161-6(Sept. 1963).

The construction, processing, and performance of a Nb_3Sn superconducting solenoid for the production of a 101 k gauss field were described. The damage to the coil as a result of being driven normal was also discussed. (C.E.S.)

959 A SENSITIVE LOW INERTIA THERMAL RESISTOR FOR HELIUM TEMPERATURES. A. N. Golovashkin and G. P. Motulevich (Inst. of Physics, Academy of Sciences, USSR). Cryogenics, 3: 167-9(Sept. 1963).

A low inertia, high sensitivity thermal resistor based on the superconducting transition is described. A sensitive element is obtained by simultaneous deposition in vacuum of lead and copper from separate evaporators. This resistor can be used to measure the thermal diffusivity of metals and alloys and to investigate rapidly varying thermal processes. (C.E.S.)

960 USE OF AN ELECTRON BEAM FOR DETECTING SUPERCONDUCTING DOMAINS OF LEAD IN ITS INTERMEDIATE STATE. M. Blackman, A. E. Curzon, and A. T. Pawlowicz (Imperial Coll. of Science and Tech., London). Nature, 200: 157(Oct. 12, 1963).

An electron beam technique is described for detecting superconducting domains in lead. A spectroscopically pure cylinder of lead, 1.1 cm long and 0.28 cm in diameter was mounted with its axis vertical in a modified horizontal electron diffraction camera. A 20 kv electron beam was focused about 15 cm from the cylinder and was deflected at 50 c/s in a vertical direction by means of suitable coils, so as to produce an electron shadow of the lead cylinder. A smooth electron shadow was taken after the applied field had been increased from zero to 37 Oe. When the field was further increased to 40 Oe the shadow edge ceased to be smooth. It became smooth again for fields in excess of about 50 Oe. (P.C.H.)

961 NUCLEAR SUSCEPTIBILITY OF SOLID HELIUM-3. A. Low Thomson, Horst Meyer, and Prakash N. Dheer (Duke Univ., Durham, N. C.). Phys. Rev., 132: 1455-64(Nov. 15, 1963).

Measurements of the nuclear susceptibility of solid He^3 in the α phase between 0.07 and 1.7°K are presented. The purity of this helium was better than 99.95%. All the results could be represented by a Curie-Weiss law $\chi = C(T + \theta)^{-1}$ indicating an antiferromagnetic exchange. While θ is smaller than about 10^{-2}°K at molar volumes larger than 22 cm^3, it appears to increase systematically when the density increases further. The magnetic exchange between the nuclei, as deduced from our data, is fairly consistent at molar volumes above 22 cm^3 with that obtained from specific heat and relaxation measurements. The higher density data, however, must be regarded as very tentative, in view of their disagreement with other data and theoretical expectations and are not presented in detail. Measurements of the longitudinal relaxation time were also carried out. In particular, for V = 19.5 cm^3/mole, T_1 was found to increase approximately as exp (2/T) below 1°K, in contradiction with relaxation data of Reich, who found T_1 to be constant in this range. New susceptibility data are also presented for a solution of 99.0% He^3, 1% He^4 and a tentative explanation is given to account for the difference with the results on the pure He^3. A method for measuring the pressure inside the solid He^3 cavity is described. On the basis of these measurements, it is argued that the phase boundary in the V-T plane is unlikely to bend upwards at temperatures below 0.8°K, as deduced from Reich's relaxation measurements. (auth)

962 SUPERCONDUCTORS WITH PLANE BOUNDARIES. David S. Falk (Univ. of Maryland, College Park). Phys. Rev., 132: 1576-90(Nov. 15, 1963).

The Gor'kov equations are solved approximately for various geometries to obtain information about the pair wave function $\Delta^*(x)$ in the vicinity of plane boundaries. The approximation method consists of assuming a model $\Delta^*_m(x)$ taken constant within the superconductor, and assuming it to be close to the correct $\Delta^*(x)$. The equations are then solved and a new $\Delta^*(x)$ is calculated. Δ^*_m is then chosen in a self-consistent manner. The problems considered are the finite and semiinfinite superconducting slabs, and semiinfinite superconducting and normal metals in contact. The effects of the boundary conditions are discussed. The calculations are performed both at zero temperature and near the critical temperature. (auth)

963 ELECTRONIC BAND STRUCTURE AND WANNIER EXCITON STATES IN SOLID KRYPTON. W. Beall Fowler (Univ. of Rochester, N. Y.). Phys. Rev., 132: 1591-9(Nov. 15, 1963).

The electronic band structure of solid krypton was calculated by a combined tight-binding and orthogonalized plane wave approach first introduced by Knox and Bassani. The crystal potential, constructed as a sum of quasiatomic potentials, contains an exchange potential which was made to approximate closely the crystal Slater exchange potential. Spin-orbit splittings were computed, and effective masses were obtained at points of high symmetry in the Brillouin zone. The smallest computed gap between valence and conduction bands is direct, is located at $\Gamma(k = 0)$, and has a magnitude of 11.3 ± 1.0 ev, in agreement with the direct gap of 11.8 ev inferred by Baldini on the basis of optical absorption data. Computed Wannier exciton absorp-

tion lines at Γ are also in agreement with Baldini's results. (auth)

964 HEAT CAPACITY OF γ–CuZn ALLOYS BELOW 4.2°K. Boyd W. Veal and John A. Rayne (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 132: 1617-19(Nov. 15, 1963).

Low-temperature heat capacity measurements were made on a series of high-purity specimens covering the entire γ phase of the Cu–Zn system. The electronic heat capacity decreases rapidly with increasing zinc concentration, thereby lending support to the hypothesis that the γ brasses are electron compounds. An excellent fit to the data may be obtained by assuming that the Fermi surface of these alloys is spherical and makes contact with the large Brillouin zone of the γ-brass structure. The Debye temperature of the alloys is 433°K and is approximately independent of zinc concentration. (auth)

965 DISLOCATIONS IN SUPERCONDUCTORS. W. W. Webb (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 11: 191-3(Sept. 1, 1963).

A simple mechanism for dislocation effects in superconductors that provides estimates of their magnitudes is proposed. Pinning by dislocations is estimated for two limiting mixed-state forms, flux vortices or fluxoids, and superconducting filaments. A macroscopic model in which the superconducting state is locally stabilized by the nonuniform stress field of a dislocation provides the pinning mechanism. The relevant second-order stress effects are primarily changes in ground-state on cohesive energy. (C.E.S.)

966 MECHANISM FOR SUPERCONDUCTIVITY IN LANTHANUM AND URANIUM. D. C. Hamilton and M. Anthony Jensen (Univ. of California, La Jolla). Phys. Rev. Letters, 11: 205-7(Sept. 1, 1963).

A mechanism for superconductivity in La and U is proposed. This mechanism depends upon the existence of a low-lying virtual f level. A model for the excitation of the virtual f level is suggested. (C.E.S.)

967 SUPERCONDUCTIVITY OF TITANIUM. R. L. Falge, Jr. (Naval Research Lab., Washington, D. C.). Phys. Rev. Letters, 11: 248-50(Sept. 15, 1963).

Superconducting properties of pure Ti and Ti–Mn alloys were investigated. It is found that for pure Ti the critical temperature (Tc) is 0.42°K and the critical magnetic field at 0°K is 56 gauss. It is shown that very small amounts of Mn in Ti depress Tc, while larger amounts raise Tc. (C.E.S.)

968 EVIDENCE FOR THE CREATION AND MOTION OF QUANTIZED VORTEX RINGS IN SUPERFLUID HELIUM. G. W. Rayfield and F. Reif (Univ. of California, Berkeley). Phys. Rev. Letters, 11: 305-8(Oct. 1, 1963).

Evidence that ions in liquid helium create well-defined quantized vortex rings whose motion can be studied in detail is presented. A Po^{210} α source is used to produce ions in the layer of liquid helium immediately adjacent to the source. A system of accelerating and retarding grids and a collector plate are used to determine the energy and velocity of the charge carriers. (C.E.S.)

969 INDUCEMENT OF SUPERCONDUCTIVITY BY VARIATION OF STRUCTURAL PARAMETERS. G. Arrhenius, Ch. J. Raub, D. C. Hamilton, and B. T. Matthias (Univ. of California, San. Diego). Phys. Rev. Letters, 11: 313(Oct. 1, 1963).

Barium–gold alloys, extending approximately from $BaAu_{3.5}$ to $BaAu_{4.3}$, were found to be superconducting with transition temperature varying between 0.35 and 0.7°K, depending on the structural state. Superconductivity in this system is critically dependent on the purity of the components. Even small amounts of ferromagnetic elements interfere seriously. The relations between composition, lattice parameters, and superconductivity are illustrated. (C.E.S.)

970 BRILLOUIN ZONE EFFECTS, SUPERCONDUCTIVITY, AND FERMI SURFACE OF INDIUM ALLOYS. M. F. Merriam (Univ. of California, San Diego). Phys. Rev. Letters, 11: 321-3(Oct. 1, 1963).

A Fermi surface–Brillouin zone interaction in the indium-rich solid solution of In–Sn and In–Pb systems that is reflected in both lattice parameter and superconducting properties is described. The specific nature of the electronic effect is discussed. The lattice parameter data also lead to a reinterpretation of the existing magnetoacoustic data on the Fermi surface of In. (C.E.S.)

971 CORRECTIONS TO THE PAIRING INTERACTION IN SUPERCONDUCTIVITY. E. M. Henley and L. Wilets (Univ. of Washington, Seattle). Phys. Rev. Letters, 11: 326-8(Oct. 1, 1963).

The ratio of the second-order terms to the first-order terms in the effective interaction between pairs is investigated, and it is found that the ratio is proportional to the strength of the interaction in the limit of small energy gaps. Three types of potentials are investigated. (C.E.S.)

972 OBSERVATION OF OSCILLATORY MAGNETOSTRICTION IN BISMUTH AT 4.2°K. Ben A. Green, Jr. and B. S. Chandrasekhar (Western Reserve Univ., Cleveland). Phys. Rev. Letters, 11: 331-2(Oct. 1, 1963).

A longitudinal magnetostriction was observed in bismuth at 4.2°K up to 25 kgauss in a direction 58° from the trigonal axis and 34° from the bisectrix, and the previously predicted oscillatory effect was found. Features that correspond closely to the de Haas-van Alphen effect were observed. The largest strain observed was 1.2×10^{-6} and occurred at 25 kgauss. Nine full periods of the oscillation were identified, the smallest occurring at 1.4 kgauss with a strain amplitude of 1.5×10^{-9}. The period was constant in reciprocal magnetic field with a value 7.3×10^{-5} $gauss^{-1}$. (C.E.S.)

973 AN APPLICATION OF THE THEORY OF MANY-FERMION SYSTEMS TO LIQUID HELIUM-THREE. Roger Edward Mills. Thesis, Columbus, Ohio, Ohio State Univ., 1963. 156p.

The theory of fermion Green's functions of the Matsubara type was developed with a view to their utilization in the calculation of thermodynamic properties of liquid He^3. The theory of 1- and 2-particle Green's functions was developed in more detail using the single particle spectral function and self-energy function, as well as a generalization of the Brueckner T-function. The 2-body correlation approximation was introduced, and the practicality of numerical calculations at that and further levels of approximation was discussed. Only gas-like properties could be predicted for non-zero temperatures because of mathematical difficulties. A modified Hartree-Fock calculation gave results for zero temperature which were not in agreement with measured data, but which were in fair agreement with the results obtained in the calculation of Brueckner and Gammel. (Dissertation Abstr.)

974 THERMAL CONDUCTIVITY OF Nb_3Sn. G. D. Cody and R. W. Cohen (RCA Labs., Princeton, N. J.). 13p. (CONF-301-14)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The thermal conductivity of vapor-deposited (0.04 cm thick) strips of near-stoichiometric Nb_3Sn is measured as a function of temperature from 2.6 to 28°K. Below the superconducting transition temperature, the thermal conductivity of this strip and one whose Nb content is about 1.5 wt % above the stoichiometric amount behave almost identically. (T.F.H.)

Neutron Physics

975 (AWRE-O-12/63) SOLUTION OF THE ONE-DIMENSIONAL MULTIGROUP STATIONARY NEUTRON TRANSPORT EQUATION ON THE IBM 7030 (STRETCH) COMPUTER. R. D. Wade, ed. (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Sept. 1963. 107p.

The program STRAINT for solution of the one-dimensional multigroup stationary neutron transport equation on the IBM 7030 is described. The program includes a range of first collision sources and handles isotropic or anisotropic scatter. Details of the coding describing the subroutines and storage names are included. Flow diagrams are given of the more complicated subroutines. (auth)

976 (CEA-2210) MESURE DES PARAMETRES DE DIFFUSION ET DE L'ANISOTROPIE DU GRAPHITE A L'AIDE D'UNE SOURCE PULSEE DE NEUTRONS. (Measurement of Diffusion Parameters and of Anisotropy of Graphite with a Pulsed Source of Neutrons). M. Sagot and H. Tellier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 21p.

The diffusion coefficient, cooling coefficient, and anisotropy of graphite were determined to be $(2.19 \pm 0.03) \times 10^5$ cm^2sec^{-1}, $(37.9 \pm 4) \times 10^5$ cm^4sec^{-2}, and 1.017 ± 0.008, respectively. The range of geometrical buckling was from 7 to 155 m^{-2}. The values obtained are compared with published values. (auth)

977 (GAMD-3033) GATHERMØS—A NEW VERSION OF THE THERMØS CODE. H. C. Honeck (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mar. 21, 1962. Contract AT(04-3)-167. 9p.

The GATHERMØS program, which solves the one-dimensional transport equation for the angular flux $\phi(x,E,\mu)$ in slab geometry, is described. In the thermal energy region the scattering is described by a full isotropic kernel plus an elastic linear anisotropic kernel. Higher order angular terms and inelastic linear anisotropic scattering are ignored. In the epithermal region the flux is given by the diffusion theory expression: $\phi(x,E,\mu) \approx E^{-k}[(1/2)\, f(x) - (3/2)\, \mu Dg(x)]$, where k,f(x), D, and g(x) are arbitrary input parameters. (auth)

978 (KAPL-M-FDF-5) A BRIEF REVIEW OF KERNEL GENERATING PROGRAMS. Francis D. Federighi (Knolls Atomic Power Lab., Schenectady, N. Y.). July 1963. Contract W-31-109-eng-52. 6p.

The similarities, differences and output form of the kernel generating programs MASS1K, SIGMA-GAS, and KERNEL are discussed. Also included is a description of the modifications of the output necessary to provide kernels for use in SWAK and SWAKRAUM. (auth)

979 (KAPL-M-RAR-1) THE USE OF DIFFUSION EQUATIONS FOR P_L AND DOUBLE-P_L CALCULATIONS. R. A. Reiter and S. Weinstein (Knolls Atomic Power Lab., Schenectady, N. Y.). July 19, 1963. Contract W-31-109-eng-52. 49p.

The spherical harmonics (P_L) and double P_L approximations to the Boltzmann transport equation in slab geometry are developed in a matrix differential equation formalism. A series of two region problems were solved in the P_L approximations up to P_{15} and the DP_L approximations up to DP_3. Angular distributions near the material interface and spatial distributions of the scalar fluxes are presented graphically. (auth)

980 (LADC-5903) SOLUTION OF THE MONOENERGETIC BOLTZMANN EQUATION FOR AN ISOTROPIC POINT SOURCE IN AN INFINITE HOMOGENEOUS ANISOTROPICALLY SCATTERING MEDIUM. K. D. Lathrop (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 7p. (CONF-187-11)

From American Nuclear Society Meeting, New York, Nov. 1963.

The effect of anisotropic scattering upon the total flux from an isotropic point source is determined, and numerical comparisons of several approximations for anisotropic scattering are given for elastic scattering by hydrogen. (auth)

981 (NAA-SR-Memo-8684) THE AGE OF FISSION NEUTRONS TO INDIUM RESONANCE ENERGY IN GRAPHITE. PART II. THEORY. Harry Alter (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [Oct. 9, 1963]. Contract AT(11-1)-Gen-8. 43p.

The first three moments of the distribution, about a point source of fission neutrons, of the slowing down density to indium resonance energy, were calculated for graphite using the Monte Carlo code, TYCHE. The effects of inelastic scattering, and of the anisotropy of elastic scattering, were included. These moments determine the moments of the flux distribution at the indium resonance energy, which are also available from experiments for comparison; such experiments are called age measurements, the age being one-sixth of the second moment. The age was calculated to be 307.4 ± 1.0 cm^2 and the fourth and sixth moments were 6.590×10^6 cm^4 and 4.006×10^{10} cm^6, respectively. These are in good agreement with experimentally measured values of 307.8 ± 2.0 cm^2, 6.577×10^6 cm^4, and 3.843×10^{10} cm^6. (auth)

982 (NAA-SR-Memo-9060) RESULTS OF THE ANALYSIS OF THE ORNL TOWER SHIELD EXPERIMENTS. R. S. Hubner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 1, 1963. Contract AT(11-1)-Gen-8. 18p.

The results of the analysis of the ORNL Tower Shield experiments using Monte Carlo techniques are presented and compared to the experimental data. Satisfactory agreement with the experiment is noted. Scattered dose, n^{th} collision dose, and scattered spectra are tabulated. (auth)

983 (NASA-TM-X-50016) COMPUTER PROGRAM FOR REDUCTION OF NEUTRON ACTIVATION FOIL DATA. L. K. Zoller (National Aeronautics and Space Administration. George C. Marshall Space Flight Center, Huntsville, Ala.). May 16, 1962. 134p. (N63-16439)

A computer program for the reduction of neutron activation foil counting data is described. Input data, sample problems, and the source program listing for the Fortran II program for the IBM 704 or 7090 are included. (D.C.W.)

984 (RT/FI(63)-22) DETERMINAZIONE DEI PARAMETRI DI DIFFUSIONE DEI MEZZI MODERANTI CON

IL METODO DELLA SORGENTE DI NEUTRONI PULSATA. I. DOWTHERM A (TEMPERATURE 20°C). (Determination of Diffusion Parameters of Mean Moderation by Means of a Pulsed Neutron Source. I. Dowtherm A at 20°C). F. Demanins, V. Rado, and F. Vinci (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia). Apr. 1963. 21p.

The macroscopic absorption cross section, diffusion constant, diffusion cooling constant, transport mean free path, extrapolated distance, diffusion length, and mean life for thermal neutrons were determined for Dowtherm A at 20°C, using a pulsed neutron source. The experimental assembly and data analysis method are described, and the results are compared with other determinations. (auth)

985 (AEC-tr-6107) CALCULATIONS OF THE NEUTRON SPECTRUM. THE TRANSPORT EQUATION AND ITS SOLUTION WITH SOME APPROXIMATIONS. H. G. Kaper, F. Le Berre, and J. P. Millot (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn. from report DEP/SEPP/164/61. July 1961. 45p.

The transport equation is derived in its general form and is considered for the cases of an elastic absorbent medium and an isotropic plane source. Different methods of solution—the method of spherical harmonics, the P_1 approximation, the age theory, and the BTH method are reviewed. Subsequently a new method of solution in the case of a heavy body, by assuming that the flux and the effective cross-sections vary little as a function of the energy, is proposed. (auth)

986 (AEC-tr-6113) ATTENUATION OF NEUTRONS IN WATER AND GRAPHITE. M. Lott, J. P. Millot, S. Passe, and A. Tattegrain (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP-152/61. [1961]. 30p.

The slowing-down in water and graphite of neutrons from a monoenergetic accelerator point source was studied. The effective displacement cross sections were determined as a function of the energy, and the slowing-down and thermal fluxes were measured for several initial neutron energies. The flux variations in graphite were interpreted by the age-after-collision method. (D.C.W.)

987 THE DIFFUSION PARAMETERS OF THERMAL NEUTRONS IN HEPTANE. T. Nilsson and N. G. Sjoestrand (Swedish Atomic Energy Board, Stockholm and Chalmers Univ. of Tech., Göteborg). Arkiv Fysik, 24: 543-8(1963).

The diffusion parameters of n-heptane were measured by means of the pulsed neutron source method at 17.5, 51.0, and 80.0°C. The diffusion length at the lowest temperature was found to be 2.59 ± 0.06 cm and the temperature coefficient 0.0071 ± 0.0012 cm per °C. The diffusion cooling coefficient obtained for heptane indicates a less efficient energy exchange between neutrons and this moderator than for water and diphenyl. (auth)

988 DISSOCIATION OF H_2 AND OTHER DIATOMIC MOLECULES BY NEUTRON BOMBARDMENT. W. W. Clendenin (Westinghouse Electric Corp., Pittsburgh). J. Chem. Phys., 39: 2283-92(Nov. 1, 1963). (WAPD-T-1584)

The perturbation treatment of neutron scattering introduced by Fermi was extended to the case of dissociation of diatomic molecules. In contrast to the usual determination of the kinematics of one fragment only, the detailed energy distributions of both fragments of the dissociated molecule were obtained. The theory was applied in the cases of the ground states of H_2, N_2^{14}, Cl_2^{35}, and HCl^{35}. The necessary conditions on perturbation theory to provide a correct treatment of recoil effects were examined and are discussed. (auth)

989 MEASUREMENT OF THE THERMAL NEUTRON DIFFUSION PARAMETERS IN DIPHENYL AND MONOISOPROPYLBIPHENYL (MIPB) BY PULSED NEUTRON METHODS. G. L. Blackshaw and A. W. Waltner (North Carolina State Coll., Raleigh). J. Nucl. Energy, Pt. A & B, 17: 341-5(Oct. 1963).

The diffusion parameters in diphenyl ($C_{12}H_{10}$) at 77°C and MIPB ($C_{15}H_{16}$) at 30°C were determined using the pulsed neutron source technique. A 1-Mev Van de Graaff accelerator was used as the pulsed source of fast neutrons utilizing the $Be^9(d,n)B^{10}$ reaction. The decay of the thermal neutron leakage from a finite cylindrical geometry was measured using a 26-channel time analyzer. By measuring the thermal neutron decay constant, λ, as a function of buckling, B^2, a least squares fit of the data to the equation $\lambda = \lambda_0 + D_0B^2 - CB^4$ yielded values of D_0, the diffusion constant, and C, the diffusion cooling coefficient. The infinite medium decay constant, λ_0, was calculated from known cross-section data. For diphenyl measurements in the buckling range from 0.0816 to 0.2811 cm^{-2}, the diffusion parameter values obtained were $D_0 = 5.437 \pm 0.117 \times 10^4$ cm^2-sec^{-1} and $C = 9.85 \pm 5.50 \times 10^3$ cm^4-sec^{-1}. The results obtained for MIPB in the buckling range from 0.0945 to 0.2952 cm^{-2} were $D_0 = 3.780 \pm 0.033 \times 10^4$ cm^2-sec^{-1} and $C = 1.25 \pm 1.43 \times 10^3$ cm^4-sec^{-1}. The values of the transport mean free path, λ_{tr}, and diffusion length, L, derived from these results were found to be less than those values predicted by current theoretical models. A preliminary investigation of λ_{tr} in MIPB as a function of temperature showed a non-linear behavior of the transport mean free path with temperature. (auth)

990 MEASUREMENT OF THE DIFFUSION PARAMETERS OF GRAPHITE. M. Sagot and H. Tellier (CEN, Saclay, France). J. Nucl. Energy, Pt. A & B, 17: 347-8 (Oct. 1963). (In French)

The diffusion parameters in graphite were measured by the pulsed neutron source technique. A 150-kev accelerator utilizing the T(d,n) reaction was used as the pulsed source of neutrons. The buckling coefficients and neutron decay constant were given for 23 graphite samples of different dimensions. The results obtained for graphite of density 1.619 at 20°C were diffusion constant $(216.6 \pm 3) \times 10^3$ cm^2 sec^{-1}, diffusion cooling coefficient $(37.9 \pm 4) \times 10^5$ cm^4 sec^{-1}, and transport mean free path (2.65 ± 0.04) cm. (C.E.S.)

991 ION BEAM POSITION STABILIZER FOR THE NG-200/1 NEUTRON GENERATOR. Endre Pasztor and Imre Veress. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 11: 311-19(1963). (In Hungarian)

The ion beam position stabilizer developed for a neutron generator operated with an analyzing magnet, is described. With the help of this device the neutron yield can be kept steady within ±2% without stabilizing the accelerator voltage. (auth)

992 DIFFUSION PARAMETERS FOR THERMAL NEUTRONS. R. Kladnik (Nuclear Inst. "J. Stefan," Ljubljana, Yugoslavia). Nucl. Sci. Eng., 17: 185-91(Oct. 1963).

The stationary velocity-dependent transport equation for

an infinite homogeneous source-free medium is solved by expanding the solution into a power series of the eigenvalues $\kappa = 1/L$. The integral equations, obtained by equating terms with the same κ_0^m, were solved numerically using the iteration procedure. The monatomic gaseous model for the scattering process was used assuming scattering cross section to be independent of the relative velocity and the absorption cross section to follow the 1/v law. A general expression for the diffusion coefficient in the absorbing medium was obtained whereas the diffusion length L is obtained as the only positive real root of an algebraic equation whose order depends on the degree of the approximation. A comparison between the calculated and measured values of the diffusion length in poisoned water shows that water can be described roughly as a monatomic gas with A = 1.9 and $l_s(\infty) = 0.40$ cm. An empirical formula for the effective temperature of the neutron velocity distribution is evaluated. (auth)

993 THE DIFFUSION PARAMETERS OF HEAVY WATER. N. K. Ganguly, F. C. Cobb, and A. W. Waltner (North Carolina State Coll., Raleigh). Nucl. Sci. Eng., 17: 223-6(Oct. 1963).

Measurements of the diffusion parameters of heavy water were made using a 1-Mev Van de Graaff accelerator utilizing the $Be^9(d,n)$ reaction under pulsed operation. The measurements were made at temperatures of 10, 20, 31, 40, and 50°C for buckling values ranging from 0.063 to 0.100 cm^{-2}. The decay of the neutron density was measured by a BF_3 counter, located under the moderator container, in conjunction with a 26-channel time analyzer. The mean-life for each buckling was computed using Peierls' method; and values of the diffusion parameters were computed by the method of least squares. The value of the diffusion constant, $(2.00 \pm 0.04) \times 10^5$ cm^2/sec at 10°C, agreed within the limits of experimental error with that found by Raievski and Horowitz, who used the modulated source method. The coefficient of the B^4 term, usually referred to as the diffusion cooling coefficient, was found to be $(3.72 \pm 0.50) \times 10^5$ cm^4/sec as compared with $(3.5 \pm 0.8) \times 10^5$ cm^4/sec as reported by Sjöstrand. (auth)

994 A NEW ASYMPTOTIC DIFFUSION THEORY. G. C. Pomraning and M. Clark, Jr. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 17: 227-33(Oct. 1963).

The variational formalism is used to derive from the monoenergetic Boltzmann equation a diffusion theory with the asymptotic transport diffusion coefficient. By considering an interface between two media as the limiting case of a medium with continuously varying properties, the boundary conditions are found to be continuity of current and a specified discontinuity in the scalar flux. The variational formalism gives the linear extrapolation distance for a pure scatterer accurate to within one-half percent. Numerical comparisons with classical (P-1) diffusion theory for a cell calculation indicate that the variational diffusion theory is significantly more accurate; the accuracy appears to be comparable with that of the P-3 method. (auth)

995 THÉORIE DE LA RÉACTION DE FISSION EN CHAINE. (Theory of the Fission Chain Reaction). Austin Blaquière. Bibliothèque des Sciences et Techniques Nucléaires. Saclay, France, Institut National des Sciences et Techniques Nucléaires, 1962. 492p.

The neutron course offered in the basic program of the Cours de Génie Atomique was developed to form the basis of the first seven chapters. These chapters discuss fission chain reactions and principles of reactors, scattering of thermal neutrons, slowing down of neutrons, transport theory, criticality of a homogeneous multiplying medium, the cell of a heterogeneous reactor, and reactor kinetics. Subsequent chapters consider nonlinearities and stabilities of reactors and neutron background of reactors. Appendices consider the resolution of the Bessel equation and Legendre polynomials. Bibliographies are given for each chapter. (J.S.R.)

996 A CONTRIBUTION TO THE THEORY OF ELEMENTARY SOLUTIONS OF THE NEUTRON TRANSPORT EQUATION. Alan Martin Jacobs. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 60p.

It is shown that the monoenergetic neutron transport equation with anisotropic scattering can be solved in closed form by use of elementary solutions. Consideration is restricted to stationary states in plane geometry with optical dimension x and direction variable μ. The elementary solutions are complete in the space of functions with prescribed boundary variation in μ at a given x. Thus, problems involving such boundary conditions are solved in a manner analogous to the eigenfunction method of solution of differential equations. For cases with boundary values given in the closed μ-interval $(-1, +1)$, the eigenfunction expansion coefficients are readily obtained through the use of orthogonality conditions. For partial range conditions of physical interest, i.e., the μ-intervals $(-1,0)$ or $(0, +1)$, orthogonality relations are not found. Rather, methods of solution of singular integral equations are employed in the evaluation of the expansion coefficients. These methods lead ultimately to inhomogeneous Fredholm integral equations of the second kind with degenerate kernels. The method of application of the elementary solution procedure to a variety of physical problems is illustrated. Equations are formulated from which analytical approximation or numerical calculation can proceed for several important theoretical problems of neutron transport. (Dissertation Abstr.)

997 THRESHOLD EFFECTS IN NEUTRON ELASTIC SCATTERING. John Thompson Wells. Thesis, Stanford, Calif., Stanford Univ., 1963. 149p.

In an attempt to observe the Wigner cusp phenomenon in neutron elastic scattering near inelastic thresholds, the differential elastic and total cross sections of Li, Fe, Zr, Ba and Ce were measured near the threshold energy for exciting the first excited states of the dominant isotopes of these elements. The energy region investigated extended approximately 300 kev on either side of threshold. The theory of Wigner cusps and "energy-averaged" Wigner cusps is supplemented by a consideration of more general angular momentum situations. Cusp predictions are given in terms of the coefficients for expansion of the cross sections into a series of Legendre polynomials. This form facilitates comparison of theory and experiment. The predicted cusp effect was too small to be observable in Li in the present experiment, and the resonance structure of the cross sections overshadowed the expected cusp effect in Fe. A drop, commencing at inelastic thresholds, was observed in the elastic cross sections of Ce, Ba, and Zr. Analysis of this effect in terms of the theory of "energy-averaged" Wigner cusps yielded good agreement between theory and experiment. This indicates that: the assumptions underlying the theory of energy-averaged cusps are indeed applicable to these nuclei; the amount of direct interaction at these energies (<2 Mev) is small for these target nuclei, otherwise, below threshold effects would be expected; and spins and parities of excited states can be

determined in favorable cases by a study of threshold effects. (M.P.G.)

Nuclear Properties and Reactions

Refer also to abstract 862.

998 (AD-299005) THE EVAPORATION MODEL AND THE SHAPE OF THE SPECTRA OF INELASTICALLY SCATTERED NEUTRONS. Kamal K. Seth (Northwestern Univ., Evanston, Ill.), R. M. Wilenzick, and T. A. Griffy (Duke Univ., Durham, N. C.). [1962]. 13p.

The shapes of the energy spectra of 6-Mev neutrons inelastically scattered from 18 medium and heavy nuclei were determined by the time-of-flight technique. It is found that if the inverse cross section for compound nucleus formation, σ_c, is assumed to be energy independent, the shapes of the reduced spectra that correspond to the density of state function differ considerably from element to element. If, however, optical model predictions for $\sigma_c(E')$ are used, the shapes of the reduced spectra for all the elements become essentially the same. It is found that even though the direct interaction contribution is less than a few per cent, the density of state function does not agree in shape with the predictions of the Fermi gas model, and that the disagreement can not be attributed to the uncertainty of the pairing energy correction or in the position of the Fermi level in the nucleus. The constant temperature model, which is based on admittedly poorer theoretical grounds, seems to fit the data better than any other model. Results for nuclear temperature and the Fermi gas coefficient are derived and are found to agree unexpectedly well with the theoretical predictions of Newton. (auth)

999 (AD-299028) INELASTIC SCATTERING OF 6-Mev NEUTRONS AND THE COMPETITION BETWEEN DIRECT INTERACTION AND COMPOUND NUCLEUS FORMATION. R. M. Wilenzick, K. K. Seth, P. R. Bevington, and H. W. Lewis (Duke Univ., Durham, N. C.). [1962]. 4p.

The inelastic scattering of 6-Mev neutrons from C^{12} and 8 heavy nuclei was determined by the time-of-flight method. Angular distributions of inelastic scattering, both to the 4.43-Mev state in C^{12} and to the statistical aggregate of levels (for heavy nuclei) agree with the compound nucleus model. The direct interaction contribution is found to be $\leqq 10\%$. (auth)

1000 (AEET/NP/7) EMISSION OF PROMPT GAMMA RAYS IN THERMAL NEUTRON FISSION OF U-235. S. S. Kapoor and R. Ramanna (India. Atomic Energy Establishment, Trombay). 1963. 34p.

The angular distributions of prompt fission gamma rays with respect to the direction of selected fission fragments in the thermal neutron fission of U^{235}, were studied for two different gamma energy groups using a gridded ionization chamber-scintillation detector assembly. The ionization chamber measured the fragment kinetic energies and the angles of their tracks with respect to the flight direction of the gamma rays detected by a plastic scintillator placed along the electric field direction of the chamber. A time-of-flight method was used to eliminate fission neutron background. From the measured angular distributions with respect to the direction of the selected light fragments, the laboratory anisotropies $\{N(0°) - N(90°)\}/N(0°)$ for gamma energies >180 and 510 kev were found to be 14.9% and 12.2%, respectively. For the ratio of the intensities of the gamma rays of energies >180 kev along the direction of the selected light and heavy fragments, a value of (0.985 ± 0.024) was obtained, showing that the laboratory anisotropies with respect to the light and heavy fragments are nearly the same. These measurements definitely show the existence of a significant anisotropy of gamma emission in the emitting fragment system after making allowance for the motion of the fragments. The emission anisotropy is explained as arising due to the polarized angular momenta of the fission fragments, which also enhances the gamma ray emission. The gamma emission from the rotating fragments is discussed with respect to the observed number and the spectrum of the gamma rays. (auth)

1001 (AERE-R-4173(Add.)) THE RATIO OF THERMAL NEUTRON CAPTURE TO FISSION FOR ^{239}Pu. M. J. Cabell and L. J. Slee (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1963. 4p.

The experimental data given in AERE-R 4173 were re-evaluated and the absolute value of α_0 for Pu^{239} was found to be 0.356 ± 0.013. A number of alphas for a reactor spectrum and for 2200 m/sec neutrons were re-calculated, and some additional possible systematic errors were considered. (auth)

1002 (CONF-46-103) NEUTRON YIELDS FROM THE $Li^7(p,n)Be^{7*}$ REACTION NEAR THRESHOLD. S. G. Buccino, C. E. Hollandsworth, and P. R. Bevington (Duke Univ., Durham, N. C.). [1963]. Contract AT(40-1)-1067. 20p.

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

The yield of the $Li^7(p,n')Be^7$ reaction leading to the 430-kev state of Be^7 was investigated near threshold with a time-of-flight system using a Li^6 glass scintillator. Total cross sections and angular distributions were determined for proton energies between 2.4 and 3.0 Mev. It is shown that the shape of the total cross section near threshold can be accounted for by assigning a spin and parity $J^\pi = 1^-$ to the level in Be^8 at 20.35 Mev (corresponding to a proton energy of 3.55 Mev). (auth)

1003 (CONF-250-2) DECAY OF N^{17} TO BOUND STATES OF O^{17}. J. C. Hopkins (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 5p.

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

The beta and gamma spectra for the decay of N^{17}, produced in $N^{15}(t,p)$ reactions, to the lower excited states in O^{17} were obtained with scintillation spectrometers feeding multichannel analyzers. β-γ and γ-γ coincidence spectra were also obtained. The β decay scheme derived, along with spins, parities, and branching fractions for the O^{17} levels, is presented and discussed. (D.C.W.)

1004 (EUR-424.f) SUR LES FACTEURS DE CORRECTION AFFECTANT L'ÉVALUATION DE LA RADIOACTIVITÉ BÊTA TOTALE DES PRODUITS DE FISSION. (On the Correction Factors Affecting the Evaluation of the Bêta Total Radioactivity of Fission Products). P. Gaglione and E. Van der Stricht (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 84p.

Data are presented which make possible the precise evaluation of the β activity of fission products measured in a variety of conditions of absorption and self-absorption. The correction factors to apply to the β measurement of fission products when the counter has been standardized with potassium-40 or with thallium-204, are tabulated. Nomograms for computing self-absorption and absorption correction factors of β emitters are presented. (auth)

1005 (IITRI-A6027-6) STUDIES OF THE RESONANCE INTEGRALS OF Re AND Tm. Quarterly Progress

Report, July 1, 1963–September 30, 1963. G. Hardie, W. E. Loewe, and W. E. Zagotta (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Oct. 14, 1963. Contract AT(11-1)-578. 30p.

Research progress on measurement of the infinitely dilute resonance integral of thulium by activation techniques, investigation of the sensitivity of the IITRI reactor for danger coefficient measurements and calculation of the effect of crystalline binding on the resonance integral of rhenium is reported. In the activation experiment all materials and apparatus were collected and assembled. Radiations that might interfere with the counting of the Tm^{170} gamma ray were studied and shown not to present a serious problem. Irradiations for a Cd ratio experiment were performed, and approximate and preliminary results for the infinitely dilute resonance integral were obtained. The cadmium ratio experiment yielded 1900 and the quasi-absolute counting technique, 1500 b. It was determined that the 0.030-in. thick Cd covers used in the Cd ratio experiment do not allow sufficient thermal neutron in-leakage to require a correction for thermal neutron activation, but a two percent correction factor must be applied to the activity of the cadmium covered foils because of the depression of the epi-thermal neutron flux. The ratio of the spectrum-averaged thermal cross sections of thulium and gold was calculated to be 1.319. Purchase of a neutron flux monitor was initiated for the danger coefficient experiment and a two speed gear box was designed to slow down rod movement. (auth)

1006 (IKF-8) UNTERSUCHUNGEN ZUR KERNSTRUKTUR VON U^{239}. (Investigation in Nuclear Structure of U^{239}). N. F. Fiebiger (Johann-Wolfgang-Goethe-Universität, Frankfurt am Main. Institut für Kernphysik). July 1963. 47p.

The (n,γ) reaction is used to study nuclear structure. The experimental method employs γ-γ-coincidences with the help of a two-parameter analyzer to yield the decay scheme. A detailed study of the reaction $U^{238}(n,\gamma)U^{239}$ is given, and a level scheme for U^{239} proposed. Levels around 0.7 Mev are believed to belong to a spin $\frac{1}{2}$ odd parity band. As the Nilsson diagram does not seem to provide a fitting state, the coupling of a single particle state to an octopole excitation is assumed to account for this odd parity band. The experimental results are shown to be compatible with this assumption. (auth)

1007 (JINR-E-1356) ENERGIES OF THE OCTUPOLE COLLECTIVE STATES WITH $I^{\pi}K = 1\text{-}0$ OF EVEN-EVEN STRONGLY DEFORMED NUCLEI. V. G. Soloviev, P. Vogel, and A. A. Korneichuk (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 8p.

The energies of the octupole collective oscillations with $I^{\pi}K = 1-0$ of even-even strongly deformed nuclei in the regions $152 \leq A \leq 186$ and $228 \leq A \leq 254$ are calculated in the framework of the superfluid nuclear model, using the method of approximate second quantization. The results are compared with experimental data. (auth)

1008 (JINR-P-1313) ISSLEDOVANIE NEITRONNYKH REZONANSON Rh^{103}. (Investigation of Neutron Resonances of Rh^{103}). Nai-yen Wang, I. Vizi, V. I. Efimov, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 15p.

The Rh^{103} neutron resonances were investigated by the time-of-flight method with a pulsed reactor. Measurements of neutron transmission, capture, and scattering were made. As a result, 17 parameters of the resonances were obtained, and the spins for 8 resonances were determined. The distribution of Γ_n^0 is not in agreement with Porter-Thomas's law, probably due to the effect of neutrons with the orbital momentum l = 1. (auth)

1009 (JINR-P-1338) TREKHKVAZICHASTICHNYE SOSTOYANIYA V DEFORMIROVANNYKH YADRAKH. (Three-Quasi-Particle States in Deformed Nuclei). N. I. Pyatov and A. S. Chernyshev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 10p.

The three-quasi-particle states in deformed nuclei were calculated in the superfluid model, taking into account the interaction between non-pairing particles, which leads to an energy multiplet in the spectra. Asymptotic coupling momenta rules for three particles were obtained. The experimental data on Lu^{177} and Hf^{177} are analyzed. (auth)

1010 (JINR-P-1341) KASKADNYE VZAIMODEISTVIYA CHASTITS S YADRAMI V OBLASTI BYSOKIKH ENERGII. (Cascade Interactions of Particles with Nuclei in High-Energy Region). V. S. Barashenkov, A. V. Boyadzhiev, L. A. Kulyukina, and V. M. Mal'tsev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 10p.

The results of calculations of intranuclear cascades in the energy region from 5 to 30 Bev are given. A comparison with experiment shows that the cascade mechanism of fast particle interaction with nuclei is predominant at these energies. (auth)

1011 (JINR-P-1351) SECHENIYA OBRAZOVANIYA I SREDNIE UGLOVYE MOMENTY SOSTAVNYKH SISTEM V REAKTSIYAKH S TYAZHELYMI IONAMI. (Cross Sections and Average Angular Momenta of Compound Systems in Reactions with Heavy Ions). V. V. Babikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 26p.

Cross sections and average angular momenta $(\bar{l}, \bar{l}^2)$ of compound systems, accompanied by complete (compound nucleus) or partial (grazing) fusion of an accelerated ion and target nucleus, are calculated using the model of the black nucleus with the sharp edge. The results are presented as universal functions of two variables (the ion energy in terms of the Coulomb barrier α and the quasi-classical parameter ρ), permitting their use in a wide range of various pairs of interacting nuclei. The difference of the results from those of Thomas is discussed. (auth)

1012 (JINR-P-1357) TEORIYA FRAGMENTATSII V PROTSESSAKH KVAZIUPRUGOGO RASSEYANIYA BYSTRYKH CHASTITS NA LEGKIKH YADRAKH. (The Theory of Fragmentation in the Processes of Quasi-Elastic Scattering of Fast Particles on Light Nuclei). V. V. Balashov, A. N. Boyarkina, and I. Rotter (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 38p.

The reactions of the quasi-elastic ejection of the individual nucleons, deuterons, α-particles and other fragments from light nuclei are considered in the impulse approximation. The momentum distribution of the clusters in nuclei, the excitation spectrum of residual nuclei at the ejection of fragments and the relation of the different canals of fragmentation are described in the framework of the shell model, taking account of the nucleon correlations. The significant role of the parentage principle is shown, and the one-particle approach to the problem is discussed. The results of the calculations are in agreement with the experiment. The subsequent experimental problems are discussed. (auth)

1013 (JINR-P-1358) IZMERENIE POPERECHNOGO SECHENIYA REAKTSII $C^{12}(p,pn)C^{11}$ PRI ENERGII 9 Gev. ($C^{12}(p,pn)C^{11}$ Cross Section at 9 Gev). B. I. Bekker, V. S.

Pantuev, V. A. Sviridov, and M. N. Khachaturyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 4p.

The $C^{12}(p,pn)C^{11}$ cross section at a proton energy of 9 Bev was measured to be 26.2 ± 1.5 mb. The present result in the limit of the experimental error is consistent with published data for other energies. (auth)

1014 (JINR-P-1361) POZITRONY PRI RASPADE Yb^{167}. (Positrons in Decay of Yb^{167}). Chuang-p'êng Wang, K. Ya. Gromov, Zh. Zhelev, V. V. Kuznetsov, Ma Huo Ik, G. Musiol, A. F. Novgordov, Shu-jun Jan, and V. A. Khalkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 10p.

In the decay of Yb^{167}, positrons with a maximum energy of 650 ± 30 kev and an intensity of (0.4 ± 0.1)%/decay and γ-rays with energies of 920, 1040, 1250, 1440, 1520 kev and intensities of 0.07, 0.3; 0.15; p0.05, 0.05%/decay were observed. An analysis of the decay scheme indicates β-decay to the 292.7 kev level of Tm^{167} and a $Yb^{167}-Tu^{167}$ mass difference of 1970 ± 30 kev. The log ft of the β transition from the ground state of Yb^{167} (5/2−/523/) to the excited level 292.7 kev of Tm^{167} (7/2−/523/) was determined to be 4.74. This value was compared with conclusions from the superfluid nuclear model. (auth)

1015 (JINR-P-1370) IZUCHENIE EFFEKTA MËSSBAUERA NA Sm^{149}. (Studies of the Mössbauer Effect in Sm^{149}). V. P. Alfimenkov, N. A. Lebedev, Yu. M. Ostanevich, T. Ruskov, and A. V. Strelkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1963. 11p.

Measurements of the Mössbauer effect for the 22.5-kev gamma-rays from Sm^{149} are described. In the spectrum of resonant absorption at 300°K one line with a width 2.3 times the expected natural width is observed. Evaluations of the probabilities of recoil-free gamma emission and absorption and the conversion coefficient of the 22.5-kev gamma transition are given. (auth)

1016 (JINR-P-1386) O TOCHNOSTI RASCHETA MOMENTA NIERTSII YADER METODOM PRINUDITEL'NOGO VRASHCHENIYA. (On the Accuracy of the Nuclear Moment of Inertia Calculated by the Cranking Model). I. N. Mikhailov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1963. 7p.

The accuracy of the cranking model is estimated by projecting the Bardeen-type functions on the space of functions with the fixed value of the angular momentum. The saddle point method is used to calculate the mean values of the projected functions. It is shown that the correction to the moment of inertia is equal to $|\Delta Z/Z_0| \approx G/\Delta$, where Z_0 is the value of the moment of inertia given by Inglis formula, G is the pairing interaction constant, and Δ is the energy gap in the spectrum of the nucleus. (auth)

1017 JINR-P-1388) EKSPERIMENTY PO NABLYUDENIYU RADIOAKTIVNOGO RASPADA S ISPUSKANIEM PROTONOV. (Experiments on Observation of Radioactive Decay Accompanied by Proton Emission). V. A. Karnaukhov, G. M. Ter-Akop'yan, L. A. Petrov, and V. G. Subbotin (Joint Inst. of Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 8p.

The composition of the radiation of the radioactive products from Ne^{20} reactions with Ni was investigated. A telescope consisting of a proportional counter and a silicon detector was used as a detector. The radioactive decay accompanied by the emission of protons with energies of 2.5 to 3 and about 5 Mev was observed. The half lives of the two emitters are about 25 and 0.1 sec, respectively. The first emitter is formed by the complete or partial fusion of nuclei accompanied by the nucleon evaporation; the second one by nucleon transfer reaction. (auth)

1018 (KAPL-M-NCF-4) ABACUS—A PROGRAM FOR THE CALCULATION OF NUCLEAR CROSS SECTIONS USING THE CLOUDY CRYSTAL BALL MODEL. E. H. Auerbach, N. C. Francis, D. T. Goldman, and C. R. Lubitz (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 19, 1963. Contract W-31-109-eng-52. 69p.

ABACUS, a digital computer program for the calculation of neutron-nucleus scattering and reaction cross sections, is described. Both shape and compound elastic cross sections are calculated. Hauser-Feshbach theory is used for the calculation of inelastic cross sections. Radial integrals are calculated for direct reaction calculation. A multi-dimensional search procedure is described for obtaining best optical model parameters. (auth)

1019 (NP-13140) DISTRIBUCION ANGULAR EN C^{13} dt C^{12} 7.65 Mev. Informe No. 13. (Angular Distribution in $C^{13}(d,t)C^{12}$ at 7.65 Mev. Report No. 13). S. Mayo (Argentina. Comisión Nazional de Energía Atómica, Buenos Aires). 1959. 8p.

An elemental carbon target enriched to 66% in C^{13} was bombarded with 14.8-Mev deuterons. The triton group corresponding to the 7.65-Mev level in C^{12} was magnetically analyzed and detected with scintillator at laboratory angles between 10 and 70 degrees. The angular distribution shows good agreement with Butler theory for $l_n = 1$, $r_o = 5.5 \times 10^{-13}$ cm; the cross section at the maximum of the angular distribution is 0.38 ± 20% mb/sterad. The reduced width of the level relative to ground state in C^{12} is 0.043. (auth)

1020 (NP-13240) NUCLEAR FISSION. A Bibliography. Review Report No. 7. L. Cwirkowska, J. Kielbasinski, and K. Sawlewicz (Polish Atomic Energy Commission. Information Center, Warsaw). 1963. 87p.

References (1457) to works published from 1946 to 1962 are listed alphabetically by first authors. The papers published in Russian are grouped ahead of those in other languages. (D.C.W.)

1021 (ORNL-TM-663) CYCLOTRON-PRODUCED RADIOISOTOPES. [PART] I. T. A. Butler and J. J. Pinajian (Oak Ridge National Lab., Tenn.). [1962]. Contract W-7405-eng-26. 16p.

A study of the internal proton beam characteristics of the ORNL 86-inch cyclotron has shown that, for (p,n) reactions, the yield can be used as a function of beam power to optimize production yields. The method of varying the proton energy over the range of 17 to 23 Mev is described. The radial distribution (radial width, ~¼ in.), beam spread (by autoradiography), and penetration (stacked foil experiments at 6° to the incident beam) are examined. The penetration of 23-Mev protons in Fe [$Fe^{56}(p,n)Co^{56}$, $Fe^{57}(p,2n)Co^{56}$, and $Fe^{58}(p,3n)Co^{56}$], Ni [$Ni^{58}(p,2p)Co^{57}$ and $Ni^{58}(p,pn + p,2n)Ni^{57} - 36$ hr $\rightarrow Co^{57}$], Cu [$Cu^{65}(p,n)Zn^{65}$], and Rh [$Rh^{103}(p,n)Pd^{103}$ and $Rh^{103}(p,pn)Rh^{102}$] was used to study low energy (p,n) and high energy (p,2n), (p,pn), or (p,3n) reactions. Optimum target thickness was 0.006 in. for single nucleon evaporation processes and ~0.003 in. for two and three nucleon evaporation processes. (auth)

1022 (PAN-428/I) POMIARY CZASOW ZYCIA STANOW IZOMERYCZNYCH W ZAKRESIE NANOSEKUNDOWYM. (Measurements of Lifetimes of Isomeric States in the Nanosecond Range). Jerzy Jastrzebski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1963. 99p.

The lifetimes of some La^{139}, Eu^{155}, Au^{192}, Au^{193}, Au^{195}, and Hg^{195} excited states were measured with a conventional fast-slow coincidence circuit and a time-to-amplitude converter adapted to work on a beta ray spectrometer. On the basis of the measurements, the reduced gamma-ray transitions probabilities were calculated and compared with the predictions of a single-particle shell model, the Nilsson model and a so-called core excitation model. (85 references.) (auth)

1023 (PAN-430/I) DETERMINATION OF THE $^{159}Dy \rightarrow {}^{159}Tb$ TRANSITION ENERGY BY THE METHOD OF THE SHAPE OF THE INTERNAL BREMSSTRAHLUNG SPECTRUM. Olgierd Wołczek, Tat-To Nguyen, and Igor Yutlandov (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1963. 34p.

The total internal bremsstrahlung (IB) spectrum accompanying the transition $Dy^{159} \rightarrow Tb^{159}$ was investigated with the aid of a scintillation spectrometer with a 200-channel analyser. The results were compared with the theory of Glauber and Martin using the χ^2 test. The spectral distribution in the selected energy interval agreed well with that predicted by the theory. On the ground of an analysis of the total IB spectrum, the Q-value for the transition $Dy^{159} \rightarrow Tb^{159}$: 370 ± 9 kev was obtained. Using the values of branchings published elsewhere, the log ft values for the transitions to the particular levels in Tb^{159} were determined to be 7.22 ± 0.03 (ground state), 7.51 ± 0.06 (1st excited state), 11.4 (2nd excited state) and 8.5 (348.1 kev level). These results were compared with the predictions of various nuclear models. (auth)

1024 (TID-19594) MEASUREMENT OF α, THE RATIO OF THE NEUTRON CAPTURE CROSS SECTION TO THE NEUTRON FISSION CROSS SECTION, FOR U^{235} IN THE ENERGY REGION FROM 4 ev TO 2 kev. G. de Saussure, L. W. Weston, R. Gwin (Oak Ridge National Lab., Tenn.); J. E. Russell, and R. W. Hockenbury (Rensselaer Polytechnic Inst., Troy, N. Y.). [1962]. Contract AT(30-3)-328. 56p.

The ratio (α) of the neutron capture to the neutron fission cross section for U^{235} was measured for neutron energies from 4 ev to 2 kev using a pulsed neutron source. A multiplate fission chamber was placed in the center of a large liquid scintillator. The gamma rays emitted by the U of this chamber, following a neutron absorption, were detected with high efficiency by the scintillator; fission fragments were detected by the fission chamber. After various background and efficiency corrections, α was obtained as the ratio of the count rate of the scintillator in anticoincidence with the fission chamber to the count rate of the scintillator in coincidence with the fission chamber. The α's obtained were used to compute η from 4 to 24 ev, in good agreement with direct measurements. (auth)

1025 (UCRL-10965) TRANSITION PATHS OF μ^- MESONS CAPTURED IN SOLID LITHIUM. Coates R. Johnson (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1963. Contract W-7405-eng-48. 105p.

The cascade to the ground state of a μ^- meson captured by an atom of solid lithium is investigated. The cascade takes place predominately through three processes. These are radiation transitions, Auger transitions involving the K shell electrons of the mesonic atom, and Auger transitions involving the band electrons of the solid. It is assumed that the meson is captured in a state of high principal quantum number ($n \sim 15$). It is found, independent of the number of K shell electrons remaining in the mesonic atom, that the principal decay paths follow, at least approximately, and if the meson is captured in a high l state, the route $\Delta n = \Delta l = -1$. For mesons captured in low l states there is a tendency for the main paths to pass through states of higher l than that given by $\Delta n = -1$, $\Delta l = -1$. Because of the presence of Auger transitions where $\Delta n = -1$, $\Delta l = 0$ and where $\Delta n = 0$, $\Delta l = -1$, the cascades contain a rather large dispersion away from the main paths and towards both large and small l. Reasons are given for expecting the same qualitative description of mesonic cascades to hold also for π^- mesons captured in lithium, and for both μ^- and π^- mesons captured in other light solids ($Z < 6$). (auth)

1026 (ZFK-PHA-9) ZUM ZERFALL DER LANGLEBIGEN LUTETIUMNUKLIDE: Lu^{173}, Lu^{174}, UND Lu^{174i}. (On the Decay of Long-Lived Lutetium Nuclides: Lu^{173}, Lu^{174}, and Lu^{174i}). Lothar Funke, Heinz Graber, Karl-Heinz Kaun, Guenther Mueller, Horst Sodan, and Lothar Werner (Germany. Zentralinstitut für Kernphysik, Dresden). Jan. 1963. 19p.

Preliminary results of measurements of the conversion electrons, γ-rays, and γ-γ-coincidences in the decay of Lu^{173}, Lu^{174}, and Lu^{174} produced by deuteron reactions with Yb_2O_3 in the Rossendorf cyclotron are presented. (auth)

1027 INVESTIGATION ON THE EXCITATION FUNCTION OF THE NUCLEAR REACTION $Be^9(d,n)B^{10}$ BY ARTIFICIALLY ACCELERATED PARTICLES IN THE 0.5–1.6 Mev ENERGY RANGE. E. Koltay (Kossuth Lajos Univ., Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 16: 93-100(1963).

The excitation function of the $Be^9(d,n)B^{10}$ nuclear reaction was taken by an energy-independent neutron detector in the 0.5 to 1.6 Mev bombarding energy range. The broad peak found near 1 Mev is probably due to concurrent processes of high intensity, taking place above 1 Mev. (auth)

1028 THE SECOND ORDER NON-UNIQUE FORBIDDEN DECAY OF Cl^{36} INTO S^{36}. D. Berényi (Inst. for Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 101-15(1963).

The internal bremsstrahlung spectrum accompanying the electron-capture decay of Cl^{36} was studied with scintillation techniques. For the maximum energy the value of 1159 ± 45 kev was obtained, which is, within experimental errors, in good agreement with the value obtained from threshold measurements of the (p,n) reaction. The Jauch diagram of the internal bremsstrahlung spectrum is linear from 700 kev to the maximum energy. From the study of the annihilation peak superimposed on the bremsstrahlung spectrum the presence of β-decay positrons in the decay of Cl^{36} is established. The branching ratio of positive β-decay present in the decay of Cl^{36} is $(2.3 \pm 0.9) \times 10^{-3}$ % and the value of log ft is 14.3. By accepting a value of 1.7 % for the branching ratio of electron capture, the ϵ_K/β^+ ratio is found to be $(7.5 \pm 3.0) \times 10^2$. This is the first experimental confirmation of the theoretical prediction that for second or higher order forbidden transitions the ratio ϵ_K/β^+ is increased and is larger than the corresponding value for the allowed transitions (this is ~90 in the present case as compared with the experimental value of 750). (auth)

1029 γ-γ ANGULAR CORRELATION MEASUREMENT ON THE 0.337 → 1.10 Mev CASCADE IN THE DECAY OF Fe^{59}. D. Berényi, Gy. Máthé, and T. Scharbert (Inst. for Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 117-19(1963).

By applying the scintillation method and sum-coincidence circuit, γ-γ angular correlation measurements were carried out on the smallest intensity 0.337 → 1.10 Mev cascade in the decay of Fe^{59}, after having reproduced the results known for the 0.145 → 1.29 Mev cascade. For the 0.337 → 1.10

Mev cascade the angular correlation function is $W(\theta) = 1 - (0.451 \pm 0.156) P_2(\cos\theta)$, which for the 1.43, 1.29, and 1.10 Mev levels excludes the spin assignments $3/2$, $5/2$, $7/2$; $5/2$, $3/2$, $7/2$; $3/2$, $1/2$, $7/2$; and $5/2$, $1/2$, $7/2$. (auth)

1030 THE ENERGY OF NEUTRONS FROM THE REACTION $Be^9(\alpha,n)C^{12}$. L. Medveczky (Nuclear Research Inst., Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 16: 155-63(1963).

The energy of the neutrons was measured by the photoemulsion method in directions of 30, 90, 120, 150, and 180° (in the laboratory system). The differential cross section for formation of the 4.433-Mev state was found to be 56, 24, 25, 29, and 30 mb/sr ± 20.4%, respectively, in the above-mentioned five directions. (auth)

1031 RADIATIVE CORRECTIONS TO INELASTIC ELECTRON SCATTERING. J. D. Bjorken (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N. Y.), 24: 201-10(Oct. 1963).

A general recipe is given for extracting the radiative corrections from a set of high energy inelastic electron scattering experiments. This recipe includes the effect of bremsstrahlung in the target material and radiation occurring during the scattering event that is nearly parallel to incident or final electron directions. This includes all corrections of order $\alpha \log (E/m)$ or $\alpha \log (E/\Delta E)$. It is shown that the effect of this internal radiation is equivalent to adding additional radiator in the beam, even when the high energy photons are taken into account. (auth)

1032 STRONG ABSORPTION MODEL FOR ELASTIC NUCLEAR SCATTERING. PART I. W. E. Frahn and R. H. Venter (Univ. of Stellenbosch, Cape Province, S. A.). Ann. Phys. (N. Y.), 24: 243-88(Oct. 1963).

A phenomenological model is presented that is capable of describing the average entrance channel phenomena of neutral and charged particles strongly interacting with complex nuclei. Instead of postulating a complex single-particle interaction potential, rather general assumptions on the asymptotic properties of the scattered wave function are used as a starting point. This approach is similar to the diffraction models of Bethe and Placzek, Akhiezer and Pomeranchuk, the sharp-cutoff model of Blair, and their generalizations by Greider and Glassgold, and by McIntyre et al. However, by means of a somewhat different formulation it is possible to give an analytical treatment for fairly arbitrary shapes of the complex scattering function consistent with the strong absorption assumption, thereby extending and unifying the earlier models. Closed-form expressions are given for the elastic scattering amplitudes and total reaction cross sections, which exhibit all known general features of the observed angular distributions and excitation functions, and permit a detailed study of their dependence on the various scattering parameters. The relation of this model to alternative descriptions of scattering in the presence of strong absorption, in particular to the complex potential model, is discussed. (auth)

1033 THE CONVERSION LINES OF THE 39.85 kev TRANSITION IN THALLIUM 208. K. D. Sevier (Uppsala Univ.). Arkiv Fysik, 25: 87-93(1963).

The conversion lines of the 39.85 kev transition in Tl^{208} were studied using a spectrograph at 0.020% resolution and an electron track counting technique for electron detection. The 39.85 L_I + 115.1 K double line was analyzed using the 39.85 L_{II} line shape as a guide. The 115.1 K line was thus found to compose (15.7 ± 1.9)% of the double line and to lie 137.2 ± 7.2 ev above the 39.85 L_I line. The E2/M1 mixing ratio of the transition was calculated from the L_I/L_{II} and L_I/L_{III} intensity ratios and found to agree with predictions of the single particle estimate. The relative intensities of the observed conversion lines are given. The recoil broadening of the lines is obvious and is treated briefly. (auth)

1034 E2-M1 MIXING IN THE 100 kev TRANSITION IN Pr^{144}. R. Bhattacharyya and S. Shastry (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 37: 357-8 (July 1963).

Gamma-gamma directional angular correlation was measured for the 34 to 100 kev cascade of Pr^{144}. The results show a pure 100 kev transition in a 0(2)2(1)1 cascade decay from the 134 kev level. (auth)

1035 AN EMPIRICAL RELATION FOR ALPHA DISINTEGRATION ENERGIES FOR MEDIUM-HEAVY ELEMENTS. M. Rama Rao (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 37: 384-8(July 1963).

It was observed that for elements with $N > 82$ and $Z < 82$, the function $(Q-0.624Z)$ has a regular variation with mass number A, where Q is the alpha disintegration energy in Mev. A plot of $(Q-0.624Z)$ vs. mass number A is found to yield a linear graph which takes up the form $(Q-0.624Z) = -0.21A-5.5$. This equation was utilized in calculating the decay energies of alpha emitters of the medium-heavy elements. The agreement between observed values and those calculated with the help of this formula lies within an average of ±5 per cent. (auth)

1036 SCATTERING OF LOW ENERGY NEUTRONS BY CARBON. Chhaya Ganguly and N. C. Sil (Indian Assn. for the Cultivation of Science, Calcutta). Indian J. Phys., 37: 389-93(July 1963).

The cross sections for scattering of low-energy neutrons by carbon were calculated by the phase-shift method. The complex nuclear potential is taken as of Woods-Saxon form, and the phases are calculated with the help of a relation given by Brysk. The theoretical values of the differential cross sections for 2.7- and 4.1-Mev neutrons agree fairly well compared with the experimental findings for the same given by Little et al., and Walt & Beyster, respectively. (auth)

1037 THE RADIATIVE CAPTURE CROSS SECTION OF ^{45}Sc FOR FAST NEUTRONS. J. L. Perkin (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. A & B, 17: 349-50(Oct. 1963).

The cross section for the $Sc^{45}(n,\gamma)Sc^{46}$ reaction was measured for neutrons in the energy range 0.15–14.65 Mev using an activation method. (C.E.S.)

1038 MEASUREMENT OF THE RESONANCE ACTIVATION INTEGRALS OF ^{58}Fe, ^{64}Zn, ^{68}Zn, AND ^{202}Hg. D. Brune and K. Jirlow (Aktiebolaget Atomenergi, Stockholm). J. Nucl. Energy, Pt. A & B, 17: 350(Oct. 1963).

The resonance activation integrals of Fe^{58}, Zn^{64}, Zn^{68}, and Hg^{202} were determined from cadmium ratio measurements. The cadmium ratio of the actual nuclides in substances in the form of thin metal foils on thin layers of powder of a suitable compound was determined by measuring the γ activity at the appropriate energies with a multichannel pulse height analyzer. (C.E.S.)

1039 FLUCTUATIONS IN THE $C^{12}(O^{16},\alpha)Mg^{24}$ REACTION. M. L. Halbert, F. E. Durham, C. D. Moak, and A. Zucker (Oak Ridge National Lab., Tenn.). Nucl. Phys., 47: 353-66(Sept. 1963).

Rapid fluctuations were observed in the excitation functions at two angles for $C^{12}(O^{16},\alpha)Mg^{24}$ reactions involving the low-lying states of Mg^{24}. The energy resolution in the entrance channel was 45 kev. The fluctuations were found

at compound-nucleus excitation energies of about 25 and 30 Mev. At 30 Mev they were as strong as at 25 Mev. The statistical theory of Ericson was applied and autocorrelation functions were used to determine the width of the fluctuations. The average width, ≈116 kev, corresponds to a compound-nucleus lifetime of 0.57×10^{-20} sec. Cross correlations between different transitions are usually small, as predicted by the theory. Upper limits on the noncompound cross section are given for the ground state transition. A comparison is made with $Al^{27}(p,\alpha)Mg^{24}$ results at the same angles and energies in the light of the statistical theory. Other possible interpretations of the experimental data are discussed. (auth)

1040 THE INTERACTIONS OF NEUTRONS WITH Li^6 AND Li^7 BETWEEN 1.5 AND 7.5 Mev. R. Batchelor and J. H. Towle (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 47: 385-407 (Sept. 1963).

The time-of-flight method was used to study the fast neutron reactions with Li^6 and Li^7 in the energy region between 1.5 and 7.5 Mev. The elastic angular distributions were compared with the predictions of a nonlocal optical model and good qualitative agreement is obtained. The results obtained on the various inelastic cross sections substantiate previous findings that the $Li^6(n,dn')$ and $Li^7(n,tn')$ cross sections are dominant, and reasonable agreement in magnitude with the results is found. The angular distributions of the inelastic neutrons leading to identifiable levels show no obvious indications of direct interaction processes. (auth)

1041 ON THE MECHANISM OF THE (d,t) REACTION. A. A. Ogloblin (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 47: 408-16(Sept. 1963).

An analysis is made of the experimental data on the (d,t) reaction obtained for a deuteron energy of 20 Mev. The character of the angular distributions and spectra shows that the Butler pick-up mechanism predominates in the (d,t) reaction in accordance with the predictions of the Shapiro theory. In case of the $Li^7(d,t)Li^6$ the proximity of a triangle graph affects the cross section, but has a very weak effect on the shape of angular distributions. The (d,t) and (p,d) reactions are compared. (auth)

1042 WIDTH OF THE 3.56 Mev (T = 1) LEVEL IN Li^6. S. J. Skorka, R. Huebner, T. W. Retz-Schmidt, and H. Wahl (Universität, Hamburg). Nucl. Phys., 47: 417-25(Sept. 1963).

The nuclear resonance fluorescence method was used to measure the width of the second excited state in Li^6. The Doppler broadened gamma radiation from the $Be^9(p,\alpha\gamma)Li^6$ reaction at the $E_p = 2.56$ Mev resonance provided a strong gamma source. Pulsed beam and time-of-flight techniques were employed to discriminate against the considerable neutron background from the parallel reaction $Be^9(p,n)B^9$. The self-absorption experiment yielded $\Gamma = (8.8^{+1.9}_{-1.3})$ ev, corresponding to a mean life of $\tau_m = (7.5 \pm 1.3) \times 10^{-17}$ sec. (auth)

1043 INVESTIGATION OF THE REACTION $Li^7(p,\alpha)He^4$ INDUCED BY POLARIZED PROTONS WITH ENERGY 0.5-2 Mev. Y. Antoufiev, I. Bondouk, A. Fickri, F. Machali, and P. V. Sorokin (Atomic Energy Establishment, Cairo). Nucl. Phys., 47: 426-32(Sept. 1963).

The sensitivity of the reaction $Li^7(p,\alpha)He^4$ with respect to proton polarization was measured in the energy range 0.5 to 2 Mev. Polarized protons were obtained from elastic scattering of $C^{12}(p,p)C^{12}$. For small energies at 45° the part of cross section that depends on the polarization does not exceed 10%; this quantity grows smoothly as the energy increases and at 2 Mev it is 60%. (auth)

1044 THE ANGULAR DISTRIBUTIONS OF PROTON GROUPS FROM THE DEUTERON BOMBARDMENT OF NEON. W. M. Jones and D. G. Waters (Associated Electrical Industries, Aldermaston, Berks, Eng.). Nucl. Phys., 47: 433-42(Sept. 1963).

The angular distributions of a number of proton groups from the bombardment of neon by 2.4-Mev deuterons were measured, and estimates of the absolute differential cross sections are given. There is evidence that at least one group with Q value in the region of zero that shows simple stripping characteristics at 8.5 Mev does not do so at 2.4 Mev deuteron energy. (auth)

1045 ENERGY OF THE FIRST EXCITED STATE OF Sr^{86}. Joseph W. Harpster, Donald L. Bennett, and Karl J. Casper (Western Reserve Univ., Cleveland). Nucl. Phys., 47: 443-8(Sept. 1963).

The energy of the gamma-ray transition following the beta decay of Rb^{86} was determined. A lithium-drifted surface-barrier solid state detector was used to measure the K photoelectrons ejected from a tantalum converter by the gamma ray; comparison was made with the internal conversion lines for the 1.063-Mev transition in Bi^{207}. The energy of the Sr^{86} gamma ray was found to be 1077.2 ± 0.5 kev. (auth)

1046 A STUDY OF PROTONS FROM In^{115} AND Au^{197} WITH 14.8 Mev INCIDENT NEUTRONS. H. S. Hans and R. K. Mohindra (Muslin Univ., Aligargh, India). Nucl. Phys., 47: 473-80(Sept. 1963).

Measurements were made of the energy spectra of protons from In^{115} at 0°, 45°, 105°, and 135° and from Au^{197} at the forward direction only when bombarded with 14.8-Mev neutrons. The experimental spectra were compared with the calculated ones on the basis of the statistical model and the theory of volume direct interactions. The agreement is fair qualitatively except at the extreme forward angles. The angular distribution plots are given and the behavior of nuclear temperatures was studied at various angles for the case of In^{115}. (auth)

1047 QUASI-FREE PROTON-PROTON SCATTERING IN 1p-SHELL NUCLEI. Tore Berggren (NORDITA. Copenhagen) and Gerhard Jacob. Nucl. Phys., 47: 481-505(Sept. 1963).

A distorted-wave analysis of (p,2p) reactions on nuclei from the 1p-shell is performed by means of the impulse approximation and the semiclassical approximation. Results are presented for an incident proton energy of 170 Mev and in one case of 450 Mev and are compared with the existing experimental data. A discussion of the results is given, and it is shown that, in general, with harmonic oscillator wave functions the absolute magnitude of the differential cross section for the angular correlation distribution is reasonably well reproduced, but the shape of the angular correlation, which gives the (distorted) momentum distribution is in general better reproduced with exponential wave functions. (auth)

1048 OPTICAL MODEL ANALYSIS OF SCATTERING OF 14 Mev NEUTRONS BY LIGHT NUCLEI. H. F. Lutz, J. B. Mason, and M. D. Karvelis (Univ. of California, Livermore). Nucl. Phys., 47: 521-4(Sept. 1963). (UCRL-7310)

The nuclear optical model is applied to the elastic scattering of 14-Mev neutrons by lithium, beryllium, boron, carbon, nitrogen, and oxygen. Good results are obtained for all elements except carbon. It is found that the radial pa-

rameter r_0 used to define the radius of the potential well ($R = r_0A^{1/3}$) increases with decreasing mass number. (auth)

1049 A MEASUREMENT OF THE DOPPLER EFFECT IN THORIUM IN A FAST NEUTRON ENERGY SPECTRUM WITH A MEDIAN FISSION ENERGY OF 190 kev. T. H. Springer and S. G. Carpenter (Atomics International, Canoga Park, Calif.). Nucl. Sci. Eng., 17: 194-9(Oct. 1963).

A preliminary measurement of the Doppler effect in metallic thorium was made in a fast neutron energy spectrum. The effect was investigated up to slug temperatures of 500°C by an oscillator technique in which sensitivities on the order of 2×10^{-8} $\Delta k/k$ can be attained with reasonable ease. The observed reactivity changes appear at this time to result largely from Doppler broadening of the resonances. This conclusion is supported by the fact that several, well-recognized correction terms were found to be unimportant under the present circumstances. Based on a straight-line approximation to the measured points, the value of $(1/\rho)(d\rho/dT)$ was found to be 7.18×10^{-5}/°C. (auth)

1050 22 GAMMA SPECTRA OF SHORT-LIVED NUCLIDES. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo). Nucleonics, 21: No. 11, 62(Nov. 1963).

A supplement is presented to Data Sheet No. 47 (NSA 17: 9549) that contains gamma spectra for nuclides with half lives of 0.8 sec to 24 min. (R.E.U.)

1051 PROBLEMS OF THE OPTICAL MODEL FOR DEUTERONS. I. PARAMETERS OF THE OPTICAL POTENTIAL. Kazimierz Grotowski (Inst. of Physical Research, Academy of Sciences, Krakow). Nukleonika, 8: 289-300(1963). (In Polish)

Problems concerning the optical model are discussed. Some special properties of deuterons as projectiles influence the optical model describing their interaction with nuclei. Several experiments were performed to obtain parameters of the optical model potential. (auth)

1052 PROBLEMS OF THE ELASTIC SCATTERING OF DEUTERONS ON ATOMIC NUCLEI. I. ANGULAR DISTRIBUTIONS FOR ELASTIC SCATTERING OF DEUTERONS. Adam Strzalkowski (Inst. of Physical Research, Polish Academy of Sciences, Krakow). Nukleonika, 8: 301-12(1963). (In Polish)

The relations between experiments on the elastic scattering of particles and the optical model of atomic nuclei are presented. The results of measurements of angular distributions in elastic scatterings of deuterons on atomic nuclei and particularly the energy dependence of these angular distributions are discussed. (auth)

1053 SOFT GAMMA-RAYS FROM THERMAL NEUTRON CAPTURE IN La, Pr, Nd, Hf, W, Os. [PART] III. M. Giannini, G. Pinto, D. Prosperi, and S. Sciuti (CNEN, Rome and Università, Rome). Nuovo Cimento (10), 29: 977-82(Aug. 16, 1963).

Previous work (NSA 17: 19329) concerning the low-lying levels of deformed nuclei of $140 \leq A \leq 190$ is extended. The isotopes studied are La^{140}, Pr^{142}, and natural mixtures of Nd, Hf, W, and Os. (R.E.U.)

1054 MEASUREMENT OF THE ANGULAR DISTRIBUTION IN THE REACTION $^{27}Al(n,p)^{27}Mg$ AT 14 Mev. L. Colli, M. Mangialajo, F. Marcelja, F. Merzari, and P. G. Sona (CISE, Milan). Nuovo Cimento (10), 29: 983-6(Aug. 16, 1963).

The reaction mechanism is studied. The energy spectrum of protons emitted by Al(n,p) was studied at angles between 0 and 120°. The transition intensity for two resolved proton groups at 1.9 and 4 Mev was calculated. (R.E.U.)

1055 DISTRIBUTION OF PARTIAL RADIATION WIDTHS. L. M. Bollinger, R. E. Cote, R. T. Carpenter, and J. P. Marion (Argonne National Lab., Ill.). Phys. Rev., 132: 1640-62(Nov. 15, 1963).

The gamma-ray spectra that result from the capture of neutrons in resonances of Hg^{199}, Pt^{195}, W^{183}, and Se^{77} are measured. A least-squares fitting of the spectra gives relative values of partial widths for various sets of high-energy radiative transitions. These widths are treated as statistical samples drawn from populations governed by a χ^2 distribution with ν degrees of freedom. A technique of hypothesis-testing that makes use of Monte Carlo calculations is used to derive unbiased values of ν from the small samples of experimental widths. The overall result of the analysis is $\nu = 1.34 \pm 0.33 \pm 0.21$. The previously reported partial radiation widths for resonances of Gd^{155}, Yb^{173}, Hf^{177}, and Hg^{201} are also analyzed. The result is $\nu = 1.14 \pm 0.44 \pm 0.21$. Thus, both sets of data are in good agreement with the value $\nu = 1$ that is expected from the Porter-Thomas description of the distribution of the widths associated with a single exit channel. (auth)

1056 ATOMIC MASSES FROM GALLIUM TO MOLYBDENUM. Richard R. Ries, Richard A. Damerow, and Walter H. Johnson, Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 132: 1662-72(Nov. 15, 1963).

The 16-in. double-focusing mass spectrometer at the University of Minnesota was used to measure the atomic mass of 42 stable isotopes in the region A = 69 to 100. The standard error associated with the results is approximately 5 parts in 10^8. Improvements in the instrument are described that result in an increase of useful resolution of a factor of 2 to 3. A set of 64 radioactive masses is calculated from the stable mass data together with β-decay energies and nuclear reaction Q values. The resultant table of masses is used to calculate total nuclear binding energies, separation energies and pairing energies for a number of nuclei in the region near N = 50. The systematics of the separation energies display very smooth characteristics except at the shell closure. Neutron pairing energies show a marked decrease in value following the shell closure. (auth)

1057 ATOMIC MASSES FROM RUTHENIUM TO XENON. Richard A. Damerow, Richard R. Ries, and Walter H. Johnson, Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 132: 1673-81(Nov. 15, 1963).

A sixteen-inch double-focusing mass spectrometer employing the peak matching method of measurement was used to measure the atomic masses of all stable isotopes in the region ruthenium to xenon. Atomic masses of 53 radioactive nuclei were calculated from mass differences derived from nuclear reaction and β-decay energies. Nucleon binding and pairing energies were calculated from the resulting mass table. The effect of the shell closure at Z = 50 on the systematics of nucleon binding and pairing energies was investigated in greater detail than has previously been possible. The discontinuity in proton binding energy is shown to be caused by a decrease in binding energy of protons beyond Z = 50. The main result of the study of nuclear systematics in this region seems to be that the binding energies of both neutrons and protons exhibit smooth behavior except for discontinuities at a shell closure. The presence of doubly charged, diatomic tellurium satellites which interfere with the singly charged ion peaks is also noted. (auth)

1058 PROPERTIES OF RADIOACTIVE Re^{189}. B. Crasemann, G. T. Emergy, W. R. Kane, and M. L. Perlman (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 1681-90(Nov. 15, 1963). (BNL-6879)

The new isotope Re^{189} was produced by fast-neutron irradiation of osmium and by the (α,p) reaction on tungsten. The rhenium was separated chemically from the target material. Beta-ray, gamma-ray, and internal conversion spectra were measured. The mass assignment is confirmed by the observation of eleven electromagnetic transitions in the Os^{189} daughter, including the 30.8-kev isomeric transition (6h), all of which were known from the decay of Ir^{189}. Rhenium-189 has a half life of 23.4 ± 1.0 h and emits beta-ray groups with end-point energies 1000, 780, and 725 kev, and probably others. Results of coincidence measurements lead to some new information about the level scheme of Os^{189}. The effects of the expected rotation-particle coupling between low-lying $K = 1/2$ and $K = 3/2$ bands in Os^{189} are discussed. (auth)

1059 PHOTODISINTEGRATION OF He^3 NEAR THE THRESHOLD. J. B. Warren, K. L. Erdman, L. P. Robertson, D. A. Axen, and J. R. MacDonald (Univ. of British Columbia, Vancouver). Phys. Rev., 132: 1691-2(Nov. 15, 1963).

The total cross section for the reaction $He^3(\gamma,p)D$ was measured at gamma-ray energies of 6.14, 6.97, and 7.08 Mev. The cross section was found to be 0.102, 0.298, and 0.307 mb at the three energies. The experimental cross-section values are compared with those of the inverse reaction $D(p,\gamma)He^3$, as an accurate check on the principle of detailed balance. (auth)

1060 SPINS OF EXCITED STATES OF Tl^{208} FROM ALPHA-GAMMA ANGULAR CORRELATIONS. Warrington C. Cobb (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 132: 1693-1706(Nov. 15, 1963).

Measurements were made of the angular correlations of the 5.60-Mev α particle occurring in the decay of Bi^{212} to the fourth excited state of Tl^{208} with the subsequent 452-kev γ ray, and of the 5.76-Mev α particle occurring in the decay to the second excited state with the subsequent competing 288- and 328-kev γ rays. The detectors employed were a 2-in. × 2-in. NaI(Tl) crystal for γ rays, and a silicon surface barrier counter for α rays. The results of the angular correlation measurements were

Transition	$W(\theta)$
5.76-Mev α — 288-kev γ	$1 - (0.182 \pm 0.018)\ P_2(\cos\theta)$
5.76-Mev α — 328-kev γ	$1 + (0.537 \pm 0.042)\ P_2(\cos\theta)$
5.60-Mev α — 452-kev γ	$1 - (0.101 \pm 0.017)\ P_2(\cos\theta)$ $+ (0.070 \pm 0.023)\ P_4(\cos\theta)$

The ratio of the intensity of the 2.88-kev γ ray to the intensity of the 328-kev γ was found to be 2.87 ± 0.22. The multipolarities of the 288- and 328-kev transitions were confirmed to be predominantly M1. A unique spin assignment of 5^+ was made to the 328-kev second excited state of Tl^{208}. Moreover, consistent assignments of 4^+, 3^+, and 6^+ are made to the third through fifth excited states. (auth)

1061 (p,γ) RESONANCE-CURVE SHAPES AND MEASUREMENTS OF RESONANCE ENERGIES WITH H_2^+ BEAMS. R. O. Bondelid and J. W. Butler (Naval Research Lab., Washington, D. C.). Phys. Rev., 132: 1710-19 (Nov. 15, 1963).

The observation of an apparent nonlinearity in the NRL 2-m radius electrostatic analyzer has led to an exhaustive investigation of (p,γ) resonance-curve shapes induced by the hydrogen molecular-ion beam. The midpoint of the rise in the thick-target yield curve obtained with the H_2^+ beam, $Al^{27}(p,\gamma)$ reaction at 992 kev, was observed to be 0.05% lower than that predicted from the corresponding observation with the H_1^+ beam. When extremely thin targets were used, the energy coordinates of the peaks of the H_1^+ and H_2^+ yield curves agreed within 0.01%. Further studies with the H_2^+ beam revealed additional deviations from expected behavior. The thick-target yield curve was seen to be asymmetric about the midpoint; there was a hump or peak near the top of the thick-target yield curve. The peaks of moderately thin-target yield curves were not shifted from resonance energy by as much as half the target thickness in energy loss units; the full widths at half-height of these moderately thin-target yield curves were greater than predicted from the full width at half-height of an extremely thin-target H_2^+ beam yield curve and the target thicknesses in energy loss units obtained with the H_1^+ beam on the same targets. The energy shifts and broadening effects of inert coatings of copper over the aluminum targets were significantly different for H_1^+ and H_2^+ beams with both beams referred to the same energy scale; and even greater broadening, but not midpoint displacement, was observed with H_1^+ and H_1^0 components stripped from the H_2^+ beam in a gas cell. These deviations from expected behavior are all explained on the basis of the mechanism of dissociation of the H_2^+ molecule, and the results are applied to calibration of beam deflection analyzers. (auth)

1062 PROTON TRANSFER TO SPECIFIC FINAL STATES IN THE REACTION $Al^{27}(O^{16},N^{15})Si^{28}$ NEAR THE COULOMB BARRIER. E. Newman, K. S. Toth, and A. Zucker (Oak Ridge National Lab., Tenn.). Phys. Rev., 132: 1720-4(Nov. 15, 1963).

The angular distribution of N^{15} particles, resulting from the transfer reaction $Al^{27}(O^{16},N^{15})Si^{28}$, was determined at three incident energies: 28.5, 30.0, and 36.0 Mev. The O^{16} ions were accelerated in the Oak Ridge Tandem Van de Graaff. Two silicon-surface barrier counters were placed at the proper angles to detect the N^{15} and Si^{28} particles in coincidence. A proportional counter imposed the further restriction that particles observed in the defining counter be nitrogen nuclei. Angular distributions were determined for two particular final-state transfers: (1) leaving both residual nuclei in their ground states, and (2) leaving the Si^{28} in its first excited state. Within experimental error the two distributions for a given bombarding energy were found to peak at approximately the same center-of-mass angle. By integrating the differential cross sections, the total reaction cross sections, in order of increasing energy, were determined to be: (1) 0.88, 1.35, and 1.37 mb for the ground-state transfers, and (2) 0.96, 1.72, and 2.72 mb for the excited-state transfers. The angular distributions were compared with the predictions of the tunneling theory of Breit bearing in mind that the theory, as formulated, is applicable only to the transfer of neutrons, not protons, and only at incident energies below the Coulomb barrier. As expected, the agreement was found to be better at 28.5 and 30.0 Mev than at 36.0 Mev. (auth)

1063 NUCLEAR ELASTIC SCATTERING OF MONOENERGETIC NEUTRON-CAPTURE GAMMA RAYS. C. S. Young and D. J. Donahue (Pennsylvania State Univ., University Park). Phys. Rev., 132: 1724-32(Nov. 15, 1963).

A source of monoenergetic gamma rays produced by neutron capture in various elements is described. A search was made for elastic scattering of these neutron-capture gamma rays from Ta, Hg, Pb, and Bi. A large scattered signal was observed when 7.285-Mev gamma rays produced

by neutron capture in iron were incident upon a lead target. Evidence is presented which indicates that this signal results from resonance scattering of these gamma rays by a level in Pb^{208} with an angular momentum quantum number of unity, and with a ground-state radiative width which is less than 4 ev. An argument is presented which indicates that it is probable that the spacing near 7 Mev in Pb^{208} of levels of the type observed is of the order of magnitude of 1400 ev. (auth)

1064 LIFETIMES OF THE 22-kev FIRST EXCITED STATES IN Eu^{151} AND Sm^{149}. O. C. Kistner, A. C. Li, and S. Monaro (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 1733-5(Nov. 15, 1963). (BNL-7124)

Lifetimes of the first excited states in Eu^{151} and Sm^{149} were measured using the delayed coincidence technique. The half lives obtained are $(9.3 \pm 0.7) \times 10^{-9}$ and $(7.6 \pm 0.5) \times 10^{-9}$ sec for Eu^{151} and Sm^{149}, respectively, which are in agreement with the lower limits determined previously by Mössbauer experiments. The two transitions, which are predominantly M1, are retarded by factors of 127 and 150 relative to Weisskopf estimates. The E2 speed of the 22-kev transition in Sm^{149} is also inferred from the known E2/M1 ratio and is found to be 83 times the single-particle speed. (auth)

1065 STUDY OF DEFORMED ODD-A NUCLEI BY THE (d,p) REACTION. Michel N. Vergnes and Raymond K. Sheline (Florida State Univ., Tallahassee). Phys. Rev., 132: 1736-52(Nov. 15, 1963).

Targets of Yb^{176} (97.5%) and Hf^{178} (95.5%) were bombarded with 12-Mev deuterons. The protons emerging from the (d,p) reaction were analyzed with ≈15-kev energy resolution at many angles utilizing a single gap, broad range magnetic spectrograph. Up to 3 Mev, 55 states were observed in Yb^{177} and 60 in Hf^{179}. Most of these states were previously unknown. The lowest energy levels in both Yb^{177} and Hf^{179} can definitely be identified with the intrinsic Nilsson orbitals $9/2^+$ (624), $7/2^-$ (514), and $1/2^-$ (510) and their associated rotational bands. The absolute cross sections and the angular distributions of the protons were measured for the reaction $Yb^{176}(d,p)Yb^{177}$. The experimental results agree very well with the predictions of the Satchler and Tobocman stripping theory for deformed nuclei. It is, therefore, established that this theory can furnish a valuable criterion for assigning spins and Nilsson orbitals in deformed nuclei. The discrepancy between experimental and calculated values of the decoupling parameter, a, for the $1/2-$ (510) band can be resolved if, in the expansion of the wave function, the theoretical Nilsson coefficients are replaced by experimentally determined coefficients. This seems to indicate that (d,p) reactions may be a useful aid in determining detailed properties of the wave functions for deformed nuclei. A comparison of the lowest states of the 107 neutron isotones Yb^{177}, Hf^{179}, W^{181}, and Os^{183} is presented. (auth)

1066 PROPERTIES OF LOW-LYING LEVELS IN Sb^{121}. F. R. Metzger and H. Langhoff (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 132: 1753-8(Nov. 15, 1963).

Resonance fluorescence in Sb^{121} was observed with Te^{121} as the source of the exciting gamma radiation. A comparison of the pulse-height distribution of the resonance scattered radiation with that of the incident radiation showed unambiguously that the 506- and the 576-kev gamma rays emitted in the decay of 17-day Te^{121} are the ground-state transitions from two separate levels in Sb^{121}. The angular distribution of the resonance radiation was studied with the resonant gamma rays from a gaseous source of Te^{121}. On the basis of this angular distribution, the most probable spin assignments are $3/2$ for the 506-kev level, and $1/2$ for the 576-kev level. The transition probabilities of these levels were determined using the centrifuge method of compensating for the recoil energy losses. Assuming a branching of $\Gamma_0/\Gamma = 0.96$, the partial width for the 576-kev E2 transition was found to be $\Gamma_0(576) = (5.4 \pm 0.6) \times 10^{-5}$ ev. For the mixed M1 + E2 506-kev transition, using $\Gamma_0/\Gamma = 0.90$, the partial width was determined to be $\Gamma_0(506) = (2.2 \pm 0.2) \times 10^{-4}$ ev. While the single-particle model predicts the observed spin sequence, it fails to account for the observed transition probabilities. Wave functions obtained recently by Kisslinger and Sorensen, and representing a combination of quasiparticle and phonon excitations, predict the observed transition probabilities rather well. (auth)

1067 CONTINUUM SPECTRA FROM THE $Be^9(He^3,\alpha)2He^4$ REACTION. W. E. Dorenbusch and C. P. Browne (Univ. of Notre Dame, Ind.). Phys. Rev., 132: 1759-62(Nov. 15, 1963).

Alpha particles from the $Be^9(He^3,\alpha)2He^4$ reaction were recorded at observation angles from 5 to 140 deg using a broad-range spectrograph. Bombarding energies were 3.00 and 4.00 Mev. The alpha continuum was measured from the reaction threshold up to a corresponding excitation energy of 15.5 Mev in the $Be^9(He^3,\alpha)Be^8$ reaction. The continuum is analyzed in terms of two possible decay modes involving spontaneous three-alpha disintegration of C^{12*} or stepwise two-body decay through states in Be^{8*}. When Coulomb barrier effects are taken into account, qualitative agreement with the data is obtained by assuming the reaction proceeds via the three-body process. The low-energy anomaly seen in the reactions $B^{11}(p,\alpha)Be^8$ and $Be^9(p,d)Be^8$ was not observed. (auth)

1068 BETA DECAY OF CARBON 10 AND THE CLUSTER MODEL. Francis J. Bartis (Univ. of Washington, Seattle). Phys. Rev., 132: 1763-7(Nov. 15, 1963).

A new toroidal spectrometer was used to determine an end point of 1865 ± 15 kev for the main position branch in the decay of C^{10}. This end point, together with the previous work on the mass 10 nuclei, leads to a Coulomb energy difference of 4.61 Mev between the mirror nuclei C^{10} and Be^{10}. According to the cluster model, developed by Wildermuth and Kanellopoulos, C^{10} is composed of a diproton cluster and two alpha-particle clusters. A lower bound on the size of the di-proton cluster may be obtained from the Li^6 charge radius, while the size of the alpha clusters can be calculated from the charge radius of C^{12}. However, these estimates of cluster size imply an upper limit of 3.52 Mev on the $C^{10}-Be^{10}$ Coulomb energy difference. Hence, it is concluded that this particular cluster model does not describe the spatial properties of these nuclear clusters in a manner consistent with experimental evidence. (auth)

1069 EXCITATION FUNCTIONS FOR THE (p,pn) AND (p,2p) REACTIONS ON Ce^{142}, 0.37 TO 2.85 Bev. B. M. Foreman, Jr. (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 1768-70 (Nov. 15, 1963). (BNL-7128)

The cross sections for the reactions $Ce^{142}(p,pn)Ce^{141}$ and $Ce^{142}(p,2p)La^{141}$ were measured at 0.37, 1.0, 2.0, and 2.85 Bev. Radiochemical techniques were used. The results indicate that over this energy range the (p,pn) cross section declines gradually from about 70 to about 60 mb, while the (p,2p) cross section declines from about 20 to about 15 mb. These results are in sharp contrast to some of those obtained for the same reactions in other investigations. The

discrepancy is discussed and it is concluded that these results are more reliable because of improvements in experimental procedures and because of greater consistency with other (p,pn) and (p,2p) reactions. (auth)

1070 MUON REACTIONS IN LIQUID HYDROGEN AND LIQUID DEUTERIUM. John H. Doede (Enrico Fermi Inst. for Nuclear Studies, Chicago and Univ. of Chicago). Phys. Rev., 132: 1782-99(Nov. 15, 1963).

The reactions of muons in liquid hydrogen containing a low concentration of deuterium, $p\mu + d \rightarrow d\mu + p \rightarrow (d\mu p)^+ \rightarrow He^3 + \mu^-$(a) or $(He^3\mu)^+ + \gamma$(b), and in liquid deuterium containing a low concentration of hydrogen, $d\mu + p \rightarrow (d\mu p)^+ \rightarrow He^3 + \mu^-$(c) or $(He^3\mu)^+ + \gamma$(d), and $d\mu + d \rightarrow (d\mu d)^+ \rightarrow He^3 + n + \mu^-$(e) or $p + t + \mu^-$(f), were investigated using the Chicago 9-in. bubble chamber. Using previously determined values for the formation and fusion rates of the $(d\mu p)^+$ ion in hydrogen in conjunction with a theoretical determination of the population of the various hyperfine levels in the $(d\mu p)^+$ ion, reaction (a) is found to occur in (15 ± 1.5)% of all $(d\mu p)^+$ fusion reactions. The formation rate of the $(d\mu d)^+$ ion in liquid deuterium is found to be $\lambda_{dd} = (3.6 \pm 1.3) \times 10^5$ sec^{-1}. The fusion rate of the $(d\mu d)^+$ is $\lambda_{df} = (2.5 \pm 0.04) \times 10^5$ sec^{-1}, and the fraction of muons which, having catalyzed reaction (e), are subsequently bound in a $(He^3\mu)^+$ muonic ion is (0.31 ± 0.0034). The rate of deexcitation to the lower hyperfine level of the $d\mu$ muonic atom via the reaction $d\mu(^3/_2) + d \rightarrow d + d\mu(^1/_2)$ was investigated and found to be $(7.9 \pm 2.8) \times 10^5$ $sec^{-1} < \lambda_{(^3/_2 - ^1/_2)} < (1.35 \pm 0.48) \times 10^6$ sec^{-1}. The interference of reactions (c), (d), (e), and (f) in the investigation of the spin-independent capture reaction $\mu^- + d \rightarrow n + n + \nu$ is discussed. (auth)

1071 HYPERFINE STRUCTURES OF THE RESONANCE LINE OF THE ARC SPECTRA OF THE ISOTOPES 135 AND 137 of BARIUM. D. A. Jackson and Duong Hong Tuan (CNRS, Bellevue, France). Phys. Rev. Letters, 11: 209-10(Sept. 1, 1963).

The values of the magnetic-moment splitting factors and of the quadrupole-moment coupling factors for the 6s6p $^1P_1$ level were calculated from the hyperfine structures of the 5535 Å line of the Ba^{135} and Ba^{137} spectra. (C.E.S.)

1072 BAND MIXING IN DEFORMED NUCLEI. J. S. Greenberg, G. G. Seaman, E. V. Bishop, and D. A. Bromley (Yale Univ., New Haven). Phys. Rev. Letters, 11: 211-14 (Sept. 1, 1963).

Measurements were carried out on the multiple Coulomb excitation radiation from bombardment of thick, oxide-free Sm^{152} targets by O^{16} ions at 36.5 to 64.0 Mev. Gamma radiation was observed directly and in coincidence with selected gamma transitions. Part of the Sm^{152} level spectrum associated with the ground-state β and γ bands was presented. It was found that the admixture of the gamma and ground-state wave functions accounts for a very small fraction of the deviations from the simple rotational model required to fit the ground-state band. (C.E.S.)

1073 BETA-DECAY TRANSITION PROBABILITIES AND MAGNETIC MOMENTS IN THE $f_{7/2}$ SHELL. B. F. Bayman, J. D. McCullen, and Larry Zamick (Princeton Univ., N. J.). Phys. Rev. Letters, 11: 215-16(Sept. 1, 1963). (PUC-1963-114)

It is shown for the specific case of the $f_{7/2}$ shell that proper many-particle wave functions can explain much of the experimental data for magnetic moments and beta-decay transitions without invoking configuration mixing. The calculations of the single-particle operators were made for all nuclei in the $f_{7/2}$ shell that have at most two particles in one of the unfilled shells and an arbitrary number of particles in the other. The wave functions used were energy eigenfunctions determined by diagonalizing the energy matrix of the residual interactions between all nucleons in the shell. (C.E.S.)

1074 IDENTIFICATION OF ZERO-SPIN STATES BY INELASTIC NEUTRON SCATTERING. L. Cranberg, C. D. Zafiratos, J. S. Levin, and T. A. Oliphant (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 11: 341-3 (Oct. 1, 1963). (LADC-5889)

Evidence that supports the predictions of large anisotropy in the angular distribution of a compound-nucleus reaction product is reported. Time-of-flight spectra obtained from the inelastic scattering of 2.5-Mev neutrons by electromagnetically separated Pb^{206} for angles of 90 and 145° are presented. The substantial anisotropy associated with the neutron group identified with a −Q value of 1.17 Mev is evident. The anisotropy is determined very strongly by the spin assumed for an excited state. The results suggest that inelastic neutron scattering provides a particularly simple and direct means of locating zero-spin states in nuclei with zero-spin ground states. (C.E.S.)

1075 EVIDENCE FOR NUCLEAR PAIRING EFFECTS AT THE FISSION BARRIER. Harold C. Britt, Richard H. Stokes, William R. Gibbs, and James J. Griffin (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 11: 343-6(Oct. 1, 1963). (LADC-5928)

To determine the properties of nuclei as a function of nuclear deformation the (d,p) fission reaction for Pu^{239} and U^{233} is investigated at excitation energies just above the fission threshold where superfluidity effects of the nuclear pairing are most in evidence, especially those effects that distinguish the finite, isolated nuclear superfluid from the infinite system. The results corroborate directly the expected discontinuity in the spectrum at the onset of two-quasiparticle excitations and the increase in the energy gap over that occurring at stable deformations for Pu^{240}. They also evidence certain structure that is consistent with the existence of low-lying collective excitations at the fission barrier analogous to those observed at the stable shape. (C.E.S.)

1076 RELATIVE METHOD FOR THE MEASUREMENT OF YIELD CURVES FOR PHOTONUCLEAR REACTIONS. O. V. Bogdankevich. Tr. Fiz. Inst., Akad. Nauk SSSR, 19: 167-86(1963). (In Russian)

A method is proposed for the measurement of yield curves for photonuclear reactions that arise from the drift of the measuring apparatus. The method is applied to studies on the 30-Mev electron synchrotron of the Lebedeff Institute for Physics but can be used in connection with any other betatron or synchrotron photonuclear investigations. A block diagram of the apparatus is shown. Circuit diagrams are displayed for the following components: integrator, equalizer, supporting voltage generator, commutator, and register. The operation of the apparatus was checked by determining the yield for (γ,n) reactions on copper, rhodium, and silver, for gamma energies from 9 to 17 Mev. (TTT)

1077 RARE NUCLEAR REACTIONS INDUCED BY 14.8 Mev NEUTRONS. Edward Turner Bramlitt. Thesis, Fayetteville, Ark., Univ. of Arkansas, 1963. 247p.

Activation cross sections for 14.8 ± 0.8 Mev neutrons were measured for $[(n,n\alpha) + (n,\alpha n)]$ reactions on the isotopes Cu^{65}, Zn^{70}, Ga^{71}, and Nb^{93}, while maximum cross-section limits for this reaction were determined for V^{51}, Ge^{76}, Br^{81}, Rb^{87}, Ag^{107}, Ag^{109}, In^{115}, Au^{197}, and Tl^{203}. Cross-section limits also were established for (n,2p) reactions

on Si^{29}, K^{41}, Sc^{45}, Ti^{50}, V^{51}, Mn^{55}, As^{75}, Y^{89}, Nb^{93}, Cs^{133}, La^{139}, Pr^{141} and Tb^{159}; and for (n,He^3) reactions on K^{41}, Sc^{45}, V^{51}, Mn^{55}, Co^{59}, Cu^{63}, As^{75}, Nb^{93}, Rh^{103}, Cs^{133}, Au^{197}, and Tl^{205}. Cross-section values for (n,γ) reactions on Y^{89}, Nb^{93}, and Pr^{141} and cross-section limits for (n,3n) reactions on Pr^{141}, Au^{197}, and Tl^{203} were determined. The [(n,np) + (n,pn)] reaction was detected with Ni^{58} but not with Mo^{92}. A cross-section value was established for the former and a maximum limit for the latter. Absolute disintegration rates required for these determinations were obtained by employing β and γ counting methods, while monitor reactions served to eliminate neutron flux measurements. Extensive use was made of radiochemical separations in order to isolate the low-yield, rare-reaction products. The Statistical Theory of nuclear reactions was employed (using parameters selected from a critical analysis of current literature) to make extensive theoretical cross-section calculations for many of the isotopes studied. Agreements between experimental and theoretical values are discussed. (M.P.G.)

1078 THE STUDY OF ANGULAR CORRELATION IN LIQUID MEDIA. William Hobert Ellis. Thesis, Tallahassee, Fla., Florida State Univ., 1963. 178p.

A study of external field effects on the angular correlation of several rare-earth and transition-element nuclides was carried out for solid and liquid sources. The anisotropy values of the angular correlation of the β-γ cascade of Tm^{170} was found to vary as a function of the physical and chemical nature of the source: solid nitrate, 0.190; liquid perchlorate, 0.269; and liquid nitrate, 0.385. The integral angular correlation of the 1.415 to 0.122 Mev γ cascade of Sm^{152} was found to be independent of the chemical and physical nature of the source, yielding the unattenuated anisotropy value of 0.419 for both a solid oxide and a liquid perchlorate source of Eu^{152}. Time-dependent measurements were conducted with the 64 to 308 kev and 64 to 198 kev γ cascades of Tm^{169}. A periodic "static field" type time-dependent response was obtained for both a solid polycrystalline hydrated chloride and dilute liquid perchlorate and nitrate sources. The periods of time-dependent variations yielded quadrupole interaction strengths $\Delta\nu$'s: nitrate solution, 192 Mc; perchlorate solution, 145 Mc; and solid hydrated chloride salt, 135 Mc. The half life of the 316 kev metastable state of Tm^{169} was measured to be 0.650 μsec. The time-dependent angular correlation measurements of the 122 to 14.4 kev γ cascade of Fe^{57} were carried out for a solid and liquid chloride source and liquid sources of ammonium perchlorate and cyanide. The measurements were found to be isotropic for all values of time delay. The resolving time of the time-to-pulse amplitude converter used in the time dependent measurements was 3.0×10^{-9} sec for Tm^{169} and 1.2×10^{-9} sec for Fe^{57}. (Dissertation Abstr.)

1079 14.7-Mev NEUTRON-INDUCED AND SPONTANEOUS FISSION YIELDS OF URANIUM-238 IN THE RARE EARTH REGION. Manchery Prabhakara Menon. Thesis, Fayetteville, Ark., Univ. of Arkansas, 1963. 171p.

Equilibrium ratios for fission products in U^{238} were measured for a number of fission products in the rare-earth region and for short-lived Sr isotopes. The results, expressed in terms of 10^{-4} disintegrations/sec/g of U^{238}, are: Ce^{141}, 4.9 ± 1.3; Ce^{143}, 4.4 ± 0.8; Ce^{144}, 3.5 ± 0.7; Nd^{147}, 3.1 ± 0.8; Pm^{147}, 3.6 ± 0.9; Pm^{149}, 1.6 ± 0.2; Sr^{91}, 4.0 ± 1.1; and Sr^{92}, 4.3 ± 1.2. The spontaneous fission half life of U^{238} was calculated to be $(7.8 \pm 0.3) \times 10^{15}$ yr. A comparative study on the mass-yield curves for the spontaneous and fast-neutron-induced fission of U^{238} was carried out, in which $U_3^{238}O_8$ was irradiated with 14.7 ± 0.4 Mev neutrons. Fission yields for 4 mass chains were measured with the following results: Ce^{141}, 3.9 ± 0.9%; Ce^{143}, 4.3 ± 0.7%; Ce^{144}, 4.5 ± 1.1%; and Pm^{147}, 2.3 ± 0.4%. A new solvent extraction method for radiochemical determination of Ce was developed during the course of this study. (M.P.G.)

1080 THE $V^{51}(p,n)Cr^{51}$ REACTION AS AN ABSOLUTE SOURCE OF kev NEUTRONS AND THE $Au^{197}(n,\gamma)Au^{198}$ CROSS SECTION IN THE kev REGION. Kent Karren Harris. Thesis, Stanford, Calif., Stanford Univ., 1963. 151p.

Use of the $V^{51}(p,n)Cr^{51}$ reaction as a neutron source offers the possibility of accurately obtaining the neutron yield by determining from the Cr^{51} disintegration rate the number of Cr^{51} atoms (and hence the number of neutrons) produced during a bombardment. The Cr^{51} activity can conveniently be determined by a measurement of the 0.32-Mev γ ray associated with the decay. The $V^{51}(p,n)Cr^{51}$ reaction yields monoenergetic neutrons up to the energy of the first-excited state of Cr^{51}, which is reported at about 0.75 Mev. No excited states below the 0.75 Mev state were observed. Neutron yields and angular distributions were obtained at selected energies in the range from 13 to 684 kev. Cross sections for the $Au^{197}(n,\gamma)Au^{198}$ reaction were determined with an absolute accuracy of about ±8% and a relative accuracy of about ±5% in the neutron-energy range from 13 to 684 kev. A 0.005-in.-thick spherical shell of Au was irradiated at each energy by neutrons produced by the proton bombardment of a thin V target at the center of the spherical shell. The neutron flux was determined by counting the Cr^{51} activity in the V target, and the capture interactions in the Au were determined by counting the 412-kev γ rays from the Au^{198} decays. Agreement with previous measurements is discussed. The theoretical cross section was calculated and is compared to the experimentally determined points. (M.P.G.)

1081 MEASUREMENT OF THE CIRCULAR POLARIZATION OF THE 1.28 Mev GAMMA RAY FOLLOWING THE BETA DECAY OF EUROPIUM 154. Richard Thomas Castle. Thesis, Athens, Ohio, Ohio Univ., 1963. 86p.

The circular-polarization anisotropy coefficient, A, for Co^{60} and Eu^{154} was measured using the transmission method. Explicit corrections are given for the fringing effects in the Fe polarization analyzer, solid angle effects, and back-scattering. The result, $A = -0.34 \pm 0.09$ (the indicated errors are standard deviation), for Co^{60} is in agreement with the theoretical value of $-\frac{1}{3}$ which serves as a calibration of the apparatus. The result, $A = -0.21 \pm 0.07$, for Eu^{154} indicates there is a maximum of 2% magnetic quadrupole mixed into the 1.28-Mev γ transition. This result implies that the K value for the 1.4-Mev level of Gd^{154} is K = 1. (Dissertation Abstr.)

1082 EXCITATION OF NUCLEAR LEVELS IN Mg^{24}, Al^{27}, AND C^{12} THROUGH INELASTIC SCATTERING OF ALPHA PARTICLES. Isam Mustafa Naqib. Thesis, Seattle, Univ. of Washington, 1962. 173p.

Elastic and inelastic scattering of 42-Mev α particles by Mg^{24}, Al^{27}, and C^{12} was studied using a single diffused-silicon solid-state detector. Angular distributions were obtained for 9 final states in Mg^{24}, 15 in Al^{27}, and 4 in C^{12}. The presence of 2 new levels at about 7 Mev in Al^{27} is disclosed. Interaction radii, collective matrix elements, parity changes, and angular momentum transfers were evaluated in terms of the inelastic diffraction theory. The inelastic scattering to the levels in Mg^{24} at 6.0 Mev and 6.43 Mev,

usually designated as 2-phonon states, exhibited single rather than double excitation features. The presence of 2 strongly excited octupole levels at about 8 Mev in Mg^{24} is suggested by the experiments. In Al^{27}, quadrupole and octupole excitations, each spread out over several levels, were observed. The experiments suggest that an intermediate rather than an extreme coupling approximation would be more appropriate for the study of the Al^{27} nucleus. In C^{12}, certain "anomalous" deviations from the inelastic diffraction predictions are observed, but the agreement with the model is good in general. The 3-assignment for the 9.63-Mev level is strongly supported by the present results. (Dissertation Abstr.)

1083 THE RADIOACTIVE DECAY OF Ni^{56}. Donald Otis Wells. Thesis, Stanford, Calif., Stanford Univ., 1963. 176p.

The radioactive decay of doubly magic Ni^{56} to Co^{56} was studied using NaI(Tl) scintillation spectrometers. Coincidence spectra, angular-correlation measurements, and delayed-coincidence measurements permitted the construction of a decay scheme with energy levels in Co^{56} at 0.00 (4^+), 0.164 (3^+), 0.984 (2^+), 1.47 (1^-,2^+), and 1.74 (1^+) Mev. The intensity balance of the γ rays indicated that the predominant decay from Ni^{56} is to the 1.74-Mev level in Co^{56} and is primarily by electron capture. Delayed-coincidence measurements gave a half life of 1.61 ± 0.10 nsec for the 1.47-Mev level. Upper limits of 0.1 nsec were set for the 0.164- and 0.984-Mev levels. The half life for the decay of the ground state of Ni^{56} was obtained by following the 0.164- and 0.272-Mev γ rays for 17 days. Least-squares analysis gave values of 6.10 ± 0.02 and 6.09 ± 0.04 days, respectively. Comparison with the nuclear shell model indicated that the ground state, the 0.164-Mev level, and the 0.984-Mev level belong primarily to the $(1f_{\frac{7}{2}}^{-1}, 2p_{\frac{3}{2}})$ configuration, while the 1.47- and 1.74-Mev levels belong primarily to the $(1f_{\frac{7}{2}}^{-1}, 1f_{\frac{5}{2}})$ configuration. Calculations using a delta-function interaction agreed with the configuration assignments and predicted an energy of 0.50 Mev for the unobserved 5^+ level of the ground configuration. Finite-range calculations for the ground configuration indicated that the residual proton-neutron interaction has a very short range and a spin-dependent part with a relative intensity of 0.08. The experimental levels of Co^{56} were compared with those of K^{40}, Co^{58}, and Co^{60}. Comparison with Co^{58} predicted the occurrence of the unobserved 5^+ level in Co^{56} at 0.501 Mev. New levels in Co^{58} were predicted at 0.450 (3^+) and 0.793 (4^+) Mev. The results of the calculations indicated that the observed energy levels of Co^{56} can be explained fairly well using the nuclear shell model. (M.P.G.)

1084 ELASTIC SCATTERING OF ALPHA PARTICLES FROM SILICON^{28}. Paul B. Weiss. Thesis, Tallahassee, Fla., Florida State Univ., 1963. 115p.

The excitation function of α particles elastically scattered from Si was observed in the bombarding energy range of 6 to 17 Mev. Fifteen angular distributions were observed in this energy range. The excitation functions are characterized by closely spaced violent anomalies. The angular distributions are rapidly varying and are strongly peaked toward the back angles. Some analyses of the angular distributions have been attempted using the principles of phase shift analysis, the Blair model, and the optical model. Trends in the optical model parameters were noted, and an angular momentum assignment for one compound-system level was made on the basis of these analyses. (Dissertation Abstr.)

1085 RADIOACTIVE DECAY OF Os^{187} +He^4 AND Os^{187} +He^3. Kottarathil Mathew Thomas. Thesis, Columbus, Ohio, Ohio State Univ., 1963. 87p.

Osmium, enriched to 45.76% in the isotope of mass number 187, was bombarded with a 2-μa beam of 24-Mev He^4 particles. The radioactive decay of the resultant sample was investigated using scintillation crystal detectors in conjunction with multi-channel analyzers. Activities of ~11 hr, ~3 days, and ~11 days were observed. By K x-ray identification, the 11-hr and 3-day activities were assigned to Pt and 11-day activity was assigned to Ir. The 11-hr Pt^{189} activity was studied in detail. Energy calibration of the γ-ray peaks observed in the spectrum of Os^{187} +He^4 during the predominance of the 11-hr activity was conducted. An energy-level scheme of Ir^{189} consistent with the results of the investigation on the 11-hr activity was proposed. A Nilsson diagram was used to predict the angular-momentum quantum numbers and parities of the ground states of Pt^{189} and Ir^{189} nuclei. The angular momentum quantum numbers and parities of all the other energy levels in the diagram were assigned in comparison with known energy level schemes of Ir^{191} and Ir^{193}. Multipole orders of the various transitions were determined in accordance with the spin and parity changes. The probabilities of the transitions were calculated. Results of the coincidence studies conducted during the predominance of the 3-day Pt^{191} in the samples of Os^{187} +He^4 are also given. They strongly indicate the existence of an energy level at 540 kev for Ir^{191} nucleus. An unsuccessful attempt was made to produce the Pt^{189} activity without the interference of the Pt^{191} activity by bombarding Os^{187} with 2-μa beam of 18-Mev He^3 particles. (M.P.G.)

1086 A MEASUREMENT OF PROTON TOTAL REACTION CROSS SECTIONS AT 16.6 Mev. Robert Elwood Pollock. Thesis, Princeton, N. J., Princeton Univ., 1963. 214p.

The technique of measurement of proton total reaction cross sections by a beam attenuation method has been adapted to the energy range of the Princeton FM Cyclotron. Foil targets of about 0.8-Mev thickness are placed in succession in a proton beam of 17 Mev, which has been cleaned of low energy protons by a magnetic spectrometer. A pair of thin plastic scintillation counters preceding the target act as a counter telescope. The beam stops in a slab of plastic scintillator subtending a large solid angle at the target. Short-recovery-time circuitry employing transistors and tunnel diodes allows average coincidence rates of 10^4 protons/sec. Previous experiments provided corrections for backward elastic and forward inelastic scattering. Optical model fits to elastic scattering angular distribtuions and to polarization data predict values for the total reaction cross section. Comparison of these predictions with the experimental results for C, Mg, Al, Ni, Cu, and Pb shows essential agreement. Factors affecting the ultimate accuracy of this experiment are considered in some detail. The facility for rapid data accumulation permitted many experimental tests for various systematic corrections. In the light of these considerations, the prospects for future investigations using this technique are discussed. (Dissertation Abstr.)

1087 A STUDY OF THE $N^{15}(p,\alpha)C^{12}$ REACTION. Gerald Roy. Thesis, Tallahassee, Fla., Florida State Univ., 1963. 149p.

The $N^{15}(p,\alpha_0)C^{12}$ and the $N^{15}(p,\alpha_1)C^{12*}$ reactions were studied with a tandem Van de Graaff electrostatic accelerator at proton energies between 3.5 Mev and 12.5 Mev. A

gas target of 97.2% enriched N-15 was used. The detectors were phosphorus-diffused junction counters. Angular distributions were measured at 39 different energies for both reactions. The exictation curves for both reactions showed much structure below proton energies of 8 Mev; above this energy, they smoothed out considerably. The excitation energy in the compound nucleus O^{18} ranged from 15.5 Mev to 23 Mev. Many of the peaks in the yield curves agreed with levels in O^{16} found by other reactions. All the angular distributions could be fitted with an expansion in odd and even orders of Legendre polynomials up to P_8; also, most of the angular distributions below 5 Mev could be fitted with orders up to P_4. This implies a maximum transferred orbital angular momentum value of 2 below 5 Mev, and a maximum value of 4 above 5 Mev. Simple arguments lead to the requirement that only T = 0 levels in O^{16} can feed the exit channels. Isotopic spin was found to be conserved in the reactions. Fits to the $N^{15}(p,\alpha_0)C^{12}$ reactions with Edwards' version of the plane wave Born approximation with exchange theory were moderately successful for 30 of the 39 angular distributions. Results seem to show that both compound nucleus and direct reaction processes interfere. Considering the amount of structure in the excitation curves, the direct reaction theory was surprisingly successful. (M.P.G.)

1088 (p,d) NUCLEAR STRUCTURE STUDIES ON MEDIUM MASS NUCLEI. Charles Donald Kavaloski. Thesis, Minneapolis, Univ. of Minnesota, 1963. 93p.

The 40-Mev proton beam from the University of Minnesota Linear Accelerator was used to study a number of medium-mass nuclei via the single-neutron pickup reaction. The outgoing deuterons were momentum analyzed in a 40-in. magnetic spectrometer and detected by anarray of 8 plastic scintillation detectors mounted in the focal plane. The output of each detector was pulse-height analyzed in a separate octant of a Nuclear Data 256 channel analyzer. Elements studied were C^{12}, O^{16}, $Mg^{24,25}$, $S^{32,34}$, Ca^{40}, and Ti^{48}. Deuteron energy spectra were taken over a range generally corresponding to 5 or 10 Mev of excitation of the final nucleus. Angular distributions were taken over a range from 6° to 60° for most of the well-defined deuteron groups. Butler fits were made to the data and reduced widths extracted. Wherever spectroscopic factors could be estimated, single-particle reduced widths were calculated from $\theta^2 = S\theta_0^2$. The $d_{\frac{3}{2}} - S_{\frac{1}{2}}$ hole-energy difference in Ca^{39} was measured and found to be 2.6 ± 0.2 Mev, and there are indications that the $d_{\frac{3}{2}} - d_{\frac{5}{2}}$ difference is ≥7 Mev. The $p_{\frac{1}{2}} - p_{\frac{3}{2}}$ difference in O^{15} was measured to be 6.4 ± 0.2 Mev. (Dissertation Abstr.)

1089 K/L+M CONVERSION RATIOS OF TRANSITIONS AMONG THE EXCITED STATES OF Sm^{148} POPULATED BY THE DECAY OF Pm^{148}. Thomas John Kurey, Jr. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 76p.

The K/L+M conversion ratios of the 286-, 550-, and 627-kev transitions among the excited states of Sm^{148} populated by the decay of Pm^{148} were measured using a shallow diffused silicon p-n junction detector. The reliability of the p-n junction detector as an instrument for the quantitative measurement of K/L+M conversion ratios was established by measuring the K/L+M conversion ratios of Hg^{203}, Au^{198}, Cs^{137}, and Bi^{207} and comparing the values obtained with those of previous workers using other methods. For the measurements of the K/L+M conversion ratios of the transitions in Sm^{148}, the p-n junction detector was employed in an arrangement which afforded the use of β-γ coincidence techniques. The values obtained were: $(K/L+M)_{286} = 7.0 \pm 1.0$; $(K/L+M)_{550} = 5.1 \pm 0.3$; and $(K/L+M)_{627} = 5.4 \pm 0.4$. The K/L+M ratio measured for the 286-kev transition, permits an M1 + E2 multipolarity assignment to this transition, and indicates a $6+ \rightarrow 6+$ transition between 2.19- and 1.90-Mev states in Sm^{148}. (Dissertation Abst.)

1090 A COMPARISON OF THE BETA SPECTRA OF BORON 12 AND NITROGEN 12: A TEST OF THE CONSERVED VECTOR CURRENT THEORY. Robert Earl McDonald. Thesis, Stanford, Calif., Stanford Univ., 1963. 135p.

The β spectra of B^{12} and N^{12} were measured in an attempt to test the conserved-vector-current theory of β decay. This theory differs from the usual Fermi theory of β decay by the addition of a contribution to the β-decay current from the meson "cloud" around the nucleus. The spectra were measured with a 180° focusing spectrometer especially designed to permit investigation of the scattering and penetration effects produced by Pb and Al spectrometer baffles. The measured shape-factor parameter, a^-, clearly depended on the baffle material used, and it is probable that the baffle material also affected the difference $a^- - a^+$. The measured difference in shape-factor parameters $a^- - a^+$ was (0.94 ± 0.44)%/Mev with the Pb baffles and (0.36 ± 0.23)%/Mev with Al baffles. The uncertain effects of baffle scattering and penetration make it impossible to draw definite conclusions about validity of the conserved vector theory from the results of this experiment. The spectrometer was calibrated in terms of the precisely known B^{12} end-point energy. If the spectrometer calibration is assumed to be identical for the B^{12} and N^{12} β-ray sources, a precise value for the end-point energy of the N^{12} spectrum may be obtained. The results for this experiment (expressed in terms of the $N^{12}-C^{12}$ mass difference) are (17.34 ± 0.03) Mev for the Pb baffles and (17.29 ± 0.03) Mev for Al. (M.P.G.)

1091 ANGULAR CORRELATION STUDIES IN THE NUCLEAR s-d SHELL. A. E. Litherland (National Research Council, Chalk River, Can.). 22p. (CONF-250-6)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

Angular correlations of the $C^{12}(C^{12},\alpha\gamma\gamma)Ne^{20}(\alpha)O^{16}$ reaction are investigated to illustrate the method for obtaining data on the properties of the nuclear levels in s-d shell nuclei. The reduced transition probabilities for the various electromagnetic transitions are presented. The energy levels and associated spin and parity values for Ne^{20} are also illustrated. (C.E.S.)

1092 EMPIRICAL FORMULA FOR HIGH-ENERGY NUCLEAR CROSS SECTIONS. Robert W. Williams (Univ. of Washington, Seattle). 17p. (CONF-250-5)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

An expression for inelastic high-energy cross sections that takes advantage of the empirical success of the geometrical formula is presented. The results agree with more accurate calculations over a wide range of nuclei and of elementary cross sections. The calculations are compared with experimental results. (C.E.S.)

Plasma Physics and Thermonuclear Processes

1093 (AD-291918) DIFFRACTION BY A PERFECTLY CONDUCTING SEMI-INFINITE SCREEN IN AN ANTISOTROPIC PLASMA. Technical Report No. 376. S. R. Seshadri and A. K. Rajagopal (Harvard Univ., Cam-

bridge, Mass. Cruft Lab.). Oct. 15, 1962. Contract Nonr-1866(32). 18p.

The scattering of a plane electromagnetic wave by a perfectly conducting semi-infinite screen embedded in a homogeneous plasma is investigated. A uniform magnetic field is assumed to be impressed externally in a direction parallel to the edge of the half-plane. The plasma is idealized by a dielectric characterized by a tensor dielectric constant. The direction of the incident wave is assumed to be in a plane perpendicular to that of the screen. This vector problem is separable into two equivalent scalar problems for which either the electric or the magnetic vector is parallel to the edge of the half-plane. It is found that for the case of the E-mode, the magnetic vector parallel to the edge of the half-plane satisfies a simple wave-equation and a new type of impedance boundary condition on the screen. This problem is formulated in terms of an integral equation which specifies the current induced on the screen. The integral equation is of the Wienner-Hopf type and is solved by the usual function-theoretic methods. A surface wave is found to exist for one orientation of the external magnetic field, and the characteristics of this surface wave are determined. (auth)

1094 (AD-420576) PROJECT SQUID. Semi-Annual Progress Report, April 1, 1963 to September 30, 1963. (Virginia. Univ., Charlottesville. School of Engineering and Applied Science). Oct. 1, 1963. Contract Nonr 3623 (00); NR-098-038. 85p.

Research progress is reported on nonsteady and non-equilibrium flow, turbulence, dynamics of gases and plasmas, thermodynamic and transport properties of gases at high temperatures and pressures, electric phenomena in two-phase flow, thermal conductivity of gases and liquids over a range of temperatures and pressures, fluid flow with suspended particles, theory of fast reactions, kinetics of elementary reactions, reaction kinetics in high-temperature gases, reactions of ions and electronically excited species with atoms and molecules in the gas phase, chemical kinetics and gas dynamics of atom and free-radical reactions, inelastic molecular collisions, solid-propellant flame mechanisms, magneto-hydrodynamics of partially ionized gases, and enthalpy fluctuations in plasma jets. (M.C.G.)

1095 (AFCRL-62-184) STUDY OF CONDITIONS IN HIGH TEMPERATURE NON-EQUILIBRIUM PLASMA CONFIGURATIONS. Scientific Report No. 7. Ralph W. Waniek (Advanced Kinetics, Inc., Costa Mesa, Calif.). Mar. 15, 1962. Contract AF19(604)-7363. 13p. (AD-289198)

Injection of plasma into the Helmholtz and counter-Helmholtz geometries, structure formation in the plasma interactions, and diffusion and instability of the plasma after structure formation were investigated. Spectroscopy of bremsstrahlung and line radiation and pickup loop signals were considered as means for observing plasma interactions and motion. (D.C.W.)

1096 (AFCRL-62-504) THE THREE-DIMENSIONAL INVERSE SCATTERING PROBLEM. Research Report No. EM-174. Irvin Kay (New York Univ., New York. Courant Inst. of Mathematical Sciences). June 1962. Contract AF19(604)-3495. 39p. (AD-287908)

The mathematical theory for an inverse scattering problem associated with determining the electron density variation in a weakly-ionized gas from the scattering amplitude for an incident plane electromagnetic wave is developed. (auth)

1097 (AFCRL-62-717) PRODUCTION OF MILLIMETER AND SUB-MILLIMETER ELECTROMAGNETIC WAVES BY THE INTERACTION OF PLASMA AND ELECTRON BEAMS WITH HIGH INTENSITY PULSED MAGNETS. Quarterly Scientific Report No. 7, January 15, 1962–April 15, 1962. Ralph W. Waniek (Advanced Kinetics, Inc., Costa Mesa, Calif.). Contract AF19(604)-7406. 32p. (AD-289473)

Theory for the zeroth order delineation of those ranges of injection parameters for a particular type of field configuration that will allow charged particles to attain regions of high magnetic field strength was developed. (D.C.W.)

1098 (AFCRL-62-858) AN EXPERIMENTAL STUDY OF A HIGH-DENSITY PLASMA IN A MAGNETIC PIPE. Report No. 62-4. Arthur M. Schneiderman (Massachusetts Inst. of Tech., Cambridge. Magnetogasdynamics Lab.). July 1962. Contract AF19(628)-221. 64p. (AD-288698)

A device for confinement of a plasma by a periodic magnetic field was investigated. The periodic confining force was produced by the motion of ionized gas through a magnetic field possessing gradients in the direction of the flow (Magnetic Pipe). Requirements to be met by the magnetic field and the gas properties were developed by order of magnitude considerations. An experimental version of the magnetic pipe was constructed and mounted on the downstream end of a shock tube. Application of the containment requirements to this device indicates that total confinement is not to be expected. However, a reduction in the plasma density near the walls of the pipe is predicted. The heat transfer to fine wires placed in this region decreased sharply upon the application of the magnetic field. The effects of the moving plasma on the magnetic field were monitored with search coils placed in the flow. These search coil measurements indicated that the magnetic field and the moving plasma were coupling in the manner expected. It is concluded that the predicted density decrease is observed. Modification of the existing equipment and further studies are suggested. (auth)

1099 (AFCRL-62-1112) RESULTS FROM THE CONSERVATION LAWS FOR MAGNETOHYDRODYNAMIC FLOW. G. L. Hand (Air Force Cambridge Research Labs., Laurence G. Hanscom Field, Bedford, Mass.). Dec. 1962. 15p. (AD-298729).

Equations similar to Bernoulli's equation are obtained for a conducting fluid with a superimposed magnetic field by considering the general statements of conservation of mass, momentum, and energy and assigning special forms to the stress tensor and internal energy of the fluid. The conservation laws are combined with the appropriate Maxwell equations. By eliminating dissipation, simple results are found. The conservation laws and Maxwell equations are applied across a discontinuity to obtain hydromagnetic shock relations and fluid-vacuum interface conditions. (auth)

1100 (AFCRL-1118) STUDIES OF CONDITIONS IN HIGH-TEMPERATURE NON-EQUILIBRIUM PLASMA CONFIGURATIONS. Scientific Report No. 6. Ralph W. Waniek (Advanced Kinetics, Inc., Costa Mesa, Calif.). Dec. 15, 1961. Contract AF19(604)-7363. 8p. (AD-289144)

The interaction and thermalization of colliding plasmas characterized by large axial velocities and generated with strong induced magnetic dipole moments were investigated. Two configurations (Helmholtz and counter-Helmholtz) in which the plasma was generated, com-

pressed, and accelerated by the same magnetic field were used. Both the interaction of the plasma with the containing vacuum field and the electromagnetic-kinetic interaction of the two colliding plasma dipole structures are considered. (auth)

1101 (ARL-63-151) PROCEEDINGS OF THE FIRST PLASMA ARC SEMINAR OF THE THERMO-MECHANICS RESEARCH LABORATORY HELD SEPTEMBER 17, 18 AND 19, 1962. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Sept. 1963. 618p.

Separate abstracts were prepared for the twenty-two papers on arcs, discharges, plasmas, and their phenomena and properties. (D.C.W.)

For abstracts of individual papers see: 476, 1102, 1103, 1104, 1105, 1106, 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119, 1120, 1121, and 1122.

1102 (ARL-63-151(p.1-17)) ON THE SHEATH OF HOLLOW ANODES. Robert C. Dean, Jr. (Dartmouth Coll., Hanover, N. H.).

An experimental and theoretical investigation of the coupled heat transfer, flow, and electrical phenomena of the gas sheath on a cooled anode is described. Two theories for the sheath were devised. Experimental tests of the theories met with irrepeatibility of the anode data, which concentrated mainly on flow symmetry. (D.C.W.)

1103 (ARL-63-151(p.18-89)) SHEATH PHENOMENA ON TRANSPIRATION COOLED ARC ANODES. C. Sheer (Columbia Univ., New York. Electronics Research Labs.).

Experiments on arcs cooled by fluid transpiration through a porous anode into the discharge zone are reviewed, along with some of the associated theory (sheath formation, etc). The equipment and plans for further experiments are also described. (D.C.W.)

1104 (ARL-63-151(p.90)) ANODE HEAT TRANSFER AND CHARACTERISTICS OF PLASMA STREAMS. E. R. F. Winter (Minnesota. Univ., Minneapolis).

The energy transfer to the anode in an argon arc was determined by an involved calorimetric method. The measured local energy transfer rates were subdivided into energy contributions stemming from the radiation, convection, and the electron energy entering the anode surface. Fluid mechanics principles were introduced into the analytical approach to the solution of the energy transfer to anodes in electric arcs. The physical characteristics of field-free plasma streams were also investigated, using radiation measurement techniques and equipment such as thermo-piles, spectrograph, and high speed camera. The temperature distribution in argon jets as function of the mass flux and the power input was determined spectroscopically. The total radiation emitted by the field-free jet was obtained with a thermo-pile. The existence of thermodynamic equilibrium ina field-free jet was checked. Finally, an over-all energy balance for plasma jets was established by applying a calorimetric method. (auth)

1105 (ARL-63-151(p.100-44)) AN EXPERIMENTAL INVESTIGATION OF A VORTEX-STABILIZED LONG ALTERNATING CURRENT ARC DISCHARGE. T. Andrada and Kurt Erfurth (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

Investigation of the mutual interaction between cylindrical arc columns and parallel gas dynamic flow fields is outlined. Preliminary results on the measurement of the radial distribution of mass flow and velocity vector of cold nitrogen flow at various axial positions along the confining discharge tube are given. It was found that at various injection angles of the gas into the vortex generator and over a wide range of mass flow rates the flow exhibited more of a solid body rotation rather than a free vortex potential flow. A low speed vortex flow in the reverse direction to the main flow occurred along the center portion of the discharge tube. The boundaries of this reverse or back flow were determined as a function of the various flow parameters. Measurements of the voltage-current relationship for various arc lengths, current, and flow field conditions indicated a negative characteristic in all cases. The overall voltage gradient, as an indication of the heat transfer from the arc column to the surrounding environment, was found to be rather insensitive to changes of mass flow rates and vortex strength. This may be explained by the fact that the arc diameter for the experimental conditions investigated was smaller than the diameter of the reverse flow core along the center of the discharge tube. Consequently, little interaction occurred between the arc column and the surrounding flow field. Also, the overall voltage gradients were found to be comparable to those measured in arcs in a quiescent atmosphere. (auth)

1106 (ARL-63-151(p.145-55)) VORTEX STABILIZED HYDROGEN ARCS. Werner Bez (Aeronautical Research Labs., Wright-Patterson AFB, Ohio).

The flow pattern in a discharge chamber for a vortex-stabilized arc is presented, using recent experimental results of various methods for flow investigation and visualization. The effect of the gas flow on the plasma column is discussed. (auth)

1107 (ARL-63-151(p.156-202)) INTERACTION BETWEEN ELECTRIC ARCS AND GAS FLOWS. Eric Baum and G. L. Cann (Electro-Optical Systems, Inc., Pasadena, Calif.).

A Maecker type segmented, water-cooled arc column apparatus in which the gas flow as well as the arc column pass through the central channel formed by the carefully aligned insulated and cooled copper segments was used in the investigations. The properties of the arc were studied when the gas flow was very small, so that all of the power is transferred to the channel walls (asymptotic column region). Results obtained with argon gas are found agreed within a reasonable accuracy with measurements made by other investigators. When the gas flow was considerably increased so that the heating extended over a considerable portion of the channel (Inlet region), the measured heating rates and efficiencies of heating compared quite well with the approximate theory of Stine and Watson. (auth)

1108 (ARL-63-151(p.203-25)) PLASMA ACCELERATION BY TRAVELING MAGNETIC WAVES. Eugene E. Covert (Massachusetts Inst. of Tech., Cambridge).

Recent research on plasma acceleration by traveling magnetic waves as a means of producing hypervelocity wind streams is summarized. Ionization of the gas, elementary analysis of the flow, and methods of improving the electrical efficiency are considered. (auth)

1109 (ARL-63-151(p.226-66)) THEORY OF THE ELECTRODE COMPONENTS OF THE ARC DISCHARGE. G. Ecker (Bonn. Universität. Institut für Theoretische Physik).

Theory for the arc region in which the influence of the electrodes is notable is presented and examined. (D.C.W.)

1110 (ARL-63-151(p.267-74)) THE SPACE CHARGE REGION NEAR THE ARC CATHODE. T. H. Lee (General Electric Co. [Missile and Space Vehicle Dept., Philadelphia]).

The behavior of electrons and ions in the space charge region was examined. A simple method for calculating the electron mean free path in a gas with a density gradient was studied, and expressions for the electron and ion densities in regions near the cathode were derived. Numerical methods for solving these Poisson equations are discussed. (D.C.W.)

1111 (ARL-63-151(p.275-93)) A MICROWAVE DIAGNOSIS OF A CYLINDRICAL PLASMA WITH ALKALI METAL INJECTION-ELECTRICAL CONDUCTIVITY. Daniel N. Cheatham, Jr. and James A. Nicholls (Michigan. Univ., Ann Arbor).

The feasibility and effectiveness of seeding high temperature gases with low ionization potential elements in order to achieve high levels of electrical conductivity in the seeded gas were investigated. A 28.5 Mc r-f heater was used to reach gas temperature levels of 2000 to 3000°K. N and air were used as working fluids; Na, K, and Cs in several forms were used as the seeding elements injected into the gas flow. Electron number densities and electrical conductivity in the resulting plasma were predicted as a function of the mole fraction seeding ratio. The electron density analysis included the assumption of thermal and chemical equilibrium in the plasma. An equilibrium analysis was used to determine the important chemical reactions in the seeding process. Freespace microwave scattering was chosen as a diagnostic technique to determine the electron density and the collision frequency, thus the electrical conductivity of the plasma. Plasma conditions included high collision frequency at one atmosphere of pressure. Both the forward and the lateral scattered field values were predicted and measured for preliminary data. The electromagnetic analysis of the scattering problem was based on the assumption of a plane polarized electromagnetic wave incident on a uniform infinitely long cylindrical plasma. Corrections for non-planar wave incidence and finite plasma length were studied in order to refine the comparison of theory and experiment. (auth)

1112 (ARL-63-151(p.294-321)) REVIEW OF THE STATUS OF KNOWLEDGE OF TRANSPORT AND THERMODYNAMIC PROPERTIES OF SELECTED GASES. [Boris Ragent] (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

Data on the thermodynamic and transport properties of gases commonly used in the production of high-temperature, high-velocity gas streams are reviewed. Air, air constituents, hydrogen, and the noble gases in temperature ranges above 4000°R and in density ranges from $\rho/\rho_0 = 1$ to 10^{-6} are considered. (D.C.W.)

1113 (ARL-63-151(p.322-35)) RADIATION CHARACTERISTICS OF METAL VAPORS. Alfred E. Wechsler (Little (Arthur D.) Inc., Cambridge, Mass.).

Experiments on the radiation properties of K and Na vapors and their effect on radiant energy transfer in high temperature gaseous systems (seeded plasma) are described. Application of preliminary results on radiation transmission through Na vapor to a high temperature plasma device indicates that significant absorption and resultant modifications of heat transfer can occur. (D.C.W.)

1114 (ARL-63-151(p.336-79)) RESEARCH ON RADIATION FROM ARC HEATED PLASMA: NITROGEN. J. C. Morris and G. R. Bach (Avco Corp. Research and Advanced Development Div., Wilmington, Mass.).

The problems of predicting and experimentally measuring important radiative properties of high temperature gases are discussed. The experimental apparatus for making determinations of these radiative properties is described, and theoretical calculations of composition, emissivity and line intensity are given. Temperature profiles for a nitrogen arc were determined from the absolute line intensity of the 4935 Å atomic nitrogen line, the relative intensity of the 3914 Å N_2^+ (1st negative) band, and from the line width. These profiles agree rather well, indicating a condition of thermal equilibrium. In addition, electron number densities were determined from the line widths; and spectral continuum absorption coefficients and total radiation were measured as a function of current and compared with theory. (auth)

1115 (ARL-63-151(p.380-7)) RADIANT HEAT TRANSFER IN ABSORBING, EMITTING, AND SCATTERING MEDIA. T. J. Love (Oklahoma State Univ., Stillwater. School of Mechanical Engineering).

Radiant heat transfer between two infinite parallel walls that absorb, emit, and scatter radiant energy and are separated by an isothermal medium is analyzed. An expression for the total radiant flux is derived. The effects of scattering (isotropic and anisotropic), particularly, are examined. (D.C.W.)

1116 (ARL-63-151(p.388-445)) RADIATION FROM AN ALTERNATING CURRENT ARC. Paul W. Schreiber (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

An experimental program for the determination of the power radiated from a vortex stabilized arc column as a function of arc and flow field parameters is outlined. Measurements of the time-average total power radiated, and time-varying power radiated over the cyclic periods of the a-c arc column are involved. The instrumentation, calibration techniques, and their limitations are discussed. A few typical radiation measurements are presented. (auth)

1117 (ARL-63-151(p.446-59)) SOME SPECTROMETRIC AND SPECTRORADIOMETRIC MEASUREMENTS OF TEMPERATURE IN PLASMAJETS. R. H. Tourin, L. R. Ryan, and H. J. Babrov (Warner & Swasey Co. Control Instrument Div., New York).

Temperatures and temperature distributions in plasmajets generated by a gas-stabilized arc were determined from spectral emission and absorption measurements, by several methods. The first method was a spectroradiometric method—the infrared monochromatic radiation (IMRA) method, in which monochromatic emission and absorption were used to determine temperature from the Kirchhoff and Planck radiation laws, without reference to energy levels or transition probabilities. This method can be used for optically thick plasmas. Plasma temperatures determined by the IMRA method were observed to increase monotonically with decreasing wavelength, indicating the existence of pronounced temperature gradients. The second method used the absolute intensity of a spectral line to known absolute transition probability to determine the temperature. The third method used the relative intensities and relative transition probabilities of two lines. The fourth method—the Boltzmann plot—is an extension of the third to many lines. The many-line method was applied to the rotational lines of the N_2^+ (O—O) band and to the atomic lines of neutral N. The relation of the IMRA and single-line methods was studied theoretically, and it was shown that the two methods are different forms of the same method, applicable to optically thick and optically thin spectral lines respectively. Temperature distributions across a plasmajet were studied by applying the single-line method along secants of varying length through

the jet, and the same data were used to determine the radial temperature distribution by means of an Abelian integral inversion. Although almost all the plasmas were optically thin in the visible region of the spectrum, their absorption was appreciable in the infrared. The measured absorptance of the atomic lines in the 1.0–1.5-μ region was as high as 0.63 for argon, and there was also an absorption continuum in this spectral region. (auth)

1118 (ARL-63-151(p.460-77)) ENERGY ADDITION TO A FLOWING GAS BY HIGH-REPETITION-RATE, ARRESTED-BREAKDOWN DISCHARGES. H. C. Early and W. N. Lawrence (Michigan. Univ., Ann Arbor).

Power transfer to flowing gases by high-pressure, rapidly repeated discharges without spark breakdown was investigated. Characteristics of discharges produced by several electrode designs and geometries at different pulse rates (fixed and alternating pulses) were examined, as well as limitations on pulse repetition rates and energy transfer per pulse. Some data on air heating by a cylindrical electrode arrangement with alternating polarity pulses are included. (D.C.W.)

1119 (ARL-63-151(p.478-94)) A REVIEW OF MAGNETICALLY INDUCED MOTION OF ELECTRIC ARCS. Walter E. Knabe (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

Experimental results on arcs in magnetic fields are briefly discussed, emphasis being given to phenomena characteristic of thermal arcs. The theory and analytic description of the arc behavior in an external magnetic field are also considered. (auth)

1120 (ARL-63-151(p.495-541)) SOME OBSERVATIONS ON THE MOTION OF ELECTRIC ARCS IN TRANSVERSE MAGNETIC FIELDS. Ward C. Roman (Aerospace Research Labs., Wright-Patterson AFB, Ohio).

The translational motion, behavior and electrical characteristics of electric arcs between parallel straight electrodes in a transverse external magnetic field at atmospheric pressure were investigated. High speed photography was used to determine the velocity and the geometrical shape of the arc, and the electrical characteristics and behavior of the discharge were measured by oscillographic techniques. Arc velocity and electrical characteristics were determined as functions of the magnetic field strength, arc currents, and electrode spacing. The effects of the electrode width, current flow direction in the electrodes, electrode arrangement in open or closed flow channels and of various combinations of direct and alternating current for operating arc discharge and magnetic field were also studied. Within the limits of the investigation experimental conditions the arc velocity was found to depend primarily on magnetic field strength and arc current. It may be represented by the simple relationship $v = 3.3\ I^{0.32}\ B^{0.61}$, where the constant 3.3 is a function of configuration. No conclusive dependency of the other parameters was found. An attempt was made to explain, by a simplified analysis, some of the observed phenomena and to predict the arc velocity as a function of the main experimental parameters. The results were compared with experimental data reported in the literature. 72 references. (auth)

1121 (ARL-63-151(p.542-56)) HEAT TRANSFER FROM PLASMAS IN THE PRESENCE OF MAGNETIC FIELDS. Stuart A. Gordon (AeroChem Research Labs., Inc., Princeton, N. J.).

Measurements of the effect of magnetic fields on heat transfer in plasma flows at a forward stagnation point are described. Results for argon indicate that the heat transfer is a function of the magnetic field direction. An attempt was made to explain the observed spread in experimental results, which diverged more than the theories with which they were compared. (D.C.W.)

1122 (ARL-63-151(p.557-95)) LAMINAR AND TURBULENT MIXING OF FIELD-FREE PLASMA. Jerry Grey (Princeton Univ., N. J.).

Experimental results on turbulent mixing in partially-ionized gases are summarized. Gas enthalpy, impact pressure, and chemical composition in an argon arc jet were measured with a calorimetric probe (described). The velocity, concentration and tempearture profiles and radial spreading are shown along with the results of energy and mass-balance calibrations of the probe. The radiation from the arc jet was measured as a function of axial and radial position and of gas enthalpy and temperature. (D.C.W.)

1123 (ESD-TDR-62-266) INCOHERENT SCATTERING FROM A PLASMA. I. THE ELECTRONIC SPECTRUM. II. THE ION-CARRIED ELECTRONIC SPECTRUM. Technical Report No. 287. M. S. Macrakis (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Nov. 14, 1962. Contract AF19(628)-500. 28p. (AD-295092)

The theory that starts from first principles (dynamics of point-charged particles) and leads to the derivation of coarse-grained properties of a plasma is reviewed in order to compute the response of the plasma to an externally applied longitudinal field. By applying the Nyquist theorem to the response function of the system, the density fluctuation spectrum is derived. A technique by which the space and time-dispersive response function of a plasma that has an arbitrary number of charged constituents can be evaluated with little effort is also presented. The technique consists of reducing the problem to one in network theory. The network corresponding to a plasma is a bank of capacitors in paralled, with each capacitor representing one constituent of the plasma. A plier's entry at any desired location in the network determines the response function to an applied external potential. (auth)

1124 (ML-894) GENERAL STUDIES IN HIGH-POWER MICROWAVE CONCEPTS. Scientific Report No. 39, October 1–December 31, 1961. (Stanford Univ., Calif. Microwave Lab.). Mar. 1962. Contract AF19(604)-1930. 24p. (AD-274557; AFCRL-62-143)

Research progress on crossed-field electron guns, electrostatic-beam and plasma parametric amplifiers, plasma theory and diagnostics, electron beam-plasma interactions, production and properties of highly ionized plasma, plasma noise, and harmonic plasma currents is reported. (D.C.W.)

1125 (NASA-TN-D-2226) INVESTIGATION OF PLASMA AFTERGLOWS WITH APPLICATION IN NITROGEN. K. C. Stotz (Rensselaer Polytechnic Inst., Troy, N. Y.). Nov. 1963. 94p.

Electron loss mechanisms in low density, low temperature plasmas are discussed, and a method of measuring the radiation temperature employing a gated microwave radiometer is described. Measurements of the ambipolar diffusion coefficient and recombination coefficient in a room temperature nitrogen plasma are obtained using the microwave transmission technique as a basic diagnostic tool. Previous results obtained by using the microwave transmission method are shown to be in error and results

of the present experiment are shown to be in agreement with microwave cavity measurements. The recombination is attributed to the dissociative recombination of the N_4^+ ion, although the three-body recombination of the N_2^+ ion may play a significant role. The temperature measurements have indicated a source of hot electrons in the early afterglow that is attributed to the presence of metastable molecules. 49 references. (auth)

1126 (NBS-7973) ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD. Fifteenth Progress Report, July 1–September 30, 1963. (National Bureau of Standards, Boulder, Colo.). Oct. 16, 1963. 10p.

Energy gap measurements on Pb and Sn films in a magnetic field show that the energy gap decreases with increasing field. The existence of a critical thickness for Pb and Sn and a critical value of the energy gap for thicknesses > the critical thickness was experimentally verified. The variation of energy gap with applied field for very thin films was calculated for several BCS parameters and room temperatures. Numerical solutions of the Ginzburg-Landau equations for thicker films with K = 0.1, 0.5, 0.55, and 0.65 showed that the critical film thickness increases by about 30% as K increases from 0 to 0.65, while for thicker films, the critical energy gap decreases with increasing K. Calculation of the critical energy gap for magnetic permeabilities ≠1 produced very different curves. A thin film of electroluminescent ZnS:Cu, MnCl was operated at 4°K in a 1 kgauss magnetic field with no visible polarization effects. The Al magnet was re-assembled and repaired. Tests on tilting-pad gas and self-acting thrust bearings designed to run in air showed that self-acting tilting-pad journal bearings and spiral groove thrust bearings may be satisfactory for use with high-speed turbo expanders. (D.C.W.)

1127 (NP-13109) ISSLEDOVANIE DVIZHENIYA OTDEL'NYKH ZARYAZHENNYKH CHASTITS V "GOFRIROVANNYKH" MAGNITNYKH POLYAKH. (Investigation of Separate Charged Particle Motion in Undulated Magnetic Fields). V. M. Balebanov, V. B. Glasko, A. L. Groshev, et al. (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii and Moscow State Univ.). 1963. 31p.

Studies were made of charged particle motion in undulated fields. Drift approximations and numerical integration of motion equations indicated the existence of injection conditions under which particles in absolute traps accumulate, preventing plasma instability. The magnitude of the drift for stability is a function of modulation depth, field period, and Larmor radius. The motion of particles in resonance fields was also studied. Experimental data on electron motion in undulated fields with magnetic traps are in agreement with theoretical calculations. (R.V.J.)

1128 (NP-13268) THE PLASMA TEST PARTICLE PROBLEM (thesis). C. W. Hirt (Michigan. Univ., Ann Arbor. Coll. of Literature, Science, and the Arts). Sept. 1963. Contract Nonr-1224(15). 159p.

A consistent and convergent treatment of the calculation of the drag on a charged test particle passing through an electron plasma at constant velocity is presented. Previous treatments are reviewed, and a modified linear solution of the hydrodynamic equations that leads to a convergent drag expression is described. A convergent spatially homogeneous electron plasma kinetic (transport) equation is also obtained, after a review of previous kinetic (divergent) equations. (D.C.W.)

1129 (NP-13274(p.37-9)) PLASMA PHYSICS. M. Raether, J. K. Aggarwal, A. Barger, et al. (Illinois. Univ., Urbana. Coordinated Science Lab.).

Instrumentation for the incoherent scattering of microwaves from plasmas was improved, and two possible error sources that might interfere with the experiment were investigated. The dynamics of the incoherent scattering in a waveguide were calculated theoretically. (auth)

1130 (R63SD77) MICROWAVE REFLECTION FROM SHOCK-PRODUCED PLASMAS. G. W. Bethke and A. D. Ruess (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Sept. 1963. Contract AF30(602)-1968. 49p. (AD-417556)

Reflection measurements were made of very low power X-band microwaves axially incident on shock-produced xenon and krypton plasmas. The electron density profile at the advancing shock front was measured with a special high resolution transverse 60 kMc interferometric probe. On comparison with free space exponential plasma-microwave interaction theory, the measured reflection coefficients were always very significantly lower than the theoretical values, the greatest disagreement being at the lowest plasma densities. It is concluded that the theoretical development of non-uniform plasma-microwave interactions within a conducting wall non-resonant container would permit a better comparison of theory with experiment. It also appears that more may have to be known about shock front (electron ramp) electron temperatures and electron collision frequencies before exact comparisons between theory and experiment are possible. (auth)

1131 (R63SD78) NON-STEADY RESPONSE OF PLASMAS TO MICROWAVE RADIATION. K. T. Yen (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Oct. 1963. Contract AF30(602)-1968. 29p. (AD-420693)

Some non-steady aspects of microwave radiation on ionized gases are studied theoretically. For weakly-ionized gases, the concept of stabilized electron temperature is introduced. It is shown that under certain conditions, ionization due to microwave radiation may be assumed to take place with the electron temperature remaining at this stabilized value. A simple expression for the ionization rate can then be obtained. Several time scales pertinent to these non-steady processes were obtained, and their relative order of magnitude is seen to be crucial in determining the nature of the non-steady response. One type of non-steady solutions for the ionization front of the gas under microwave radiation is considered in some detail. Three different modes of response are possible depending on the initial electron density distributions. In particular, when the initial distribution is of the form b times a exp (a ξ)/[1 + b exp (a ξ)], for $\xi \leq 0$, where a and b are constant, the ionization front will propagate in the negative ξ direction toward the source of microwave radiation at a constant speed and with the same profile of electron density. (auth)

1132 (SEL-62-092) INTERACTION BETWEEN A COLD PLASMA (OR DIELECTRIC) AND A CAVITY. Technical Report No. 251-2. K. I. Thomassen (Stanford Univ., Calif. Electron Devices Lab.). Aug. 1962. Contract AF49(638)-660. 35p. (AD-288014)

The interaction between a cylindrical plasma column (or dielectric material) and a resonant cavity through which it protrudes is analyzed. From the results, the dielectric constant and loss, or in the case of a plasma,

the plasma frequency and collision frequency can be determined, given measured values of the resonant frequency shift and change in the cavity Q. This theory differs from the earlier theory of Brown in that it treats a cavity of more general shape and takes into account the subtle boundary effects at the openings through which the plasma is admitted. These effects may be calculated by estimating the field variation over the part of the cylindrical plasma surface that lies inside the cavity. (auth)

1133 PLASMA EQUATION OF STATE. Don C. Kelly (Miami Univ., Oxford, Ohio). Am. J. Phys., 31: 827-8(Nov. 1963).

The equation of state for a plasma is derived from the virial theorem. The result is expressed in a form that shows that deviations from the ideal gas law are minor under conditions which validate use of the Debye–Hückel potential. (auth)

1134 ACCELERATION OF A ROTATING PLASMA. J. Bergstroem, S. Holmberg, and B. Lehnert (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 25: 49-64(1963).

A rotating plasma is generated by a discharge across a magnetic field. The energy source of the plasma consists of two condenser banks. The first bank is used to ionize and preaccelerate the gas in the discharge chamber. At some time after the start, when a fully ionized state has been reached, a second condenser bank is connected to the plasma and a further acceleration takes place. By this arrangement the second acceleration of the plasma can be studied in absence of ionization phenomena and other complications involved in the starting process. When only small amounts of energy are extracted from the second bank, the second acceleration takes place without any momentum loss in addition to that which can be explained by viscous forces. On the other hand, when large energies are extracted from the second bank a saturation of the voltage across the plasma is observed. This is followed by a reduced impedance of the plasma, the appearance of irregularities in the discharge, an increasing equivalent capacity and an increasing release of gas from walls and electrodes. The introduction of a copper wall does not remove the voltage saturation. The experiments suggest that the plasma is stable as long as the ratio between the energy of rotation and the magnetic field energy is less than 0.2. Above this value the voltage saturation and the increased loss rate can possibly be explained by instabilities, or by some other loss mechanism such as that produced by an interaction between the plasma and the end insulators. (auth)

1135 MASS-SPECTROMETRIC STUDY OF ENERGY DISTRIBUTION OF IONS IN PLASMA. A. B. Rastrepin, I. M. Zolototrubov, and Yu. P. Bugai (Physico-Technological Inst., Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 1113-17(Aug. 1963). (In Russian)

A spectrometer assembly and the method used to study the energy distribution of ions in a plasma are described. A. Kistemaker (Physica 16: 198(1950)) ion source provided the hydrogen plasma. The conclusions reached were that the presence of gas targets between the plasma source and the assembly distorts the ion energy distribution. Therefore the assembly may be used only in studying energy distributions in low-pressure plasmas or injected plasma aggregates in a vacuum. The presence of gaseous contaminants in the source distorts the shape of the distribution curve. A change in the contaminant state results in changes in the shape of the curve and in the distribution drift on the energy scale. Depending on the method of operation, the energy distribution of ions drifting from the cathode is greatly changed. (TTT)

1136 NOTES ON PLASMA-ELECTRON OSCILLATIONS. K. G. Emeleus and A. Garscadden (Queen's Univ., Belfast). Nuovo Cimento (10), 26: Suppl. No. 1, 40-9 (1962).

Electron and ion oscillations are studied in a low-voltage beam-controlled plasma. It is found that either the cathode or anode (or both) may afford control of the oscillations. Factors influencing the amplitudes of the oscillations, the electron energy distributions, and the fine structure of the spatial distributions of electron concentration are studied. (T.F.H.)

1137 A SIMPLE STABILITY CRITERION FOR ACCELERATED PLASMAS. J. Katzenstein (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (10), 29: 851-8(Aug. 16, 1963).

The stability of a diamagnetic plasma supported in a uniform gravitational field by an arbitrary magnetic field is investigated. The system is found to be unstable against the growth of flutes along the field lines (Rayleigh-Taylor instability) unless the center of curvature of the field-plasma interface and hence field lines at the plasma surface lie in the vacuum and the magnitude of the radius of curvature is less than twice the barometric scale height kT/Mg of the plasma where M is the ion mass. The role of such instabilities in limiting the performance of various devices employed or proposed for the acceleration of plasma to high directed kinetic energies is examined. (auth)

1138 INTRODUCTION OF LITHIUM AND STRONTIUM INTO A DIRECT CURRENT ARC PLASMA IN HELIUM AT HIGH PRESSURE. V. P. Garashchuk and V. P. Zakarov. Opt. Spectry. (USSR) (English Transl.), 15: 66(July 1963).

The concentration of lithium and strontium in a d-c arc plasma of helium was measured by the Rozhdestvenskii hook method. The measurements for lithium were conducted at pressures up to 8.5 atm and for strontium up to 6 atm. Measurements confirm the previous proposal that the increase in the concentration of atoms in an arc plasma with increasing pressure is due to the decrease in the diffusion of atoms out of the arc gap. (C.E.S.)

1139 TWIN-CHANNEL INSTABILITY IN A TOROIDAL PLASMA AT B_z-FIELD REVERSAL. S. Gerglund, B. G. Jyoti, and S. Westerlund (Uppsala Univ.). Phys. Rev. Letters, 11: 181-3(Sept. 1, 1963).

Toroidal z-pinches were initiated in a slowly varying positive field, and a negative field was superimposed. The effect of the outer field was found to be largely independent of the field delay provided that the base discharge reaches a conductivity that is large enough so that the two fields become separated from each other. Then the internal field enhancement becomes larger, the plasma is better confined, and the electron temperature rises, but only for a limited time. When the negative field replaces the positive one at the plasma boundaries, a rapid change develops. The field passes from its positive value to a negative value of the same amplitude in a few μsec. (C.E.S.)

1140 RESONANCE OSCILLATIONS IN A HOT NON-UNIFORM PLASMA COLUMN. J. C. Nickel, J. V. Parker, and R. W. Gould (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 11: 183-5(Sept. 1, 1963).

Observations of resonances in a low-density plasma column and a quantitative theory of the frequency spectrum that is in excellent agreement with these measurements are reported. (C.E.S.)

1141 TRANSVERSE FIELD INTERACTIONS OF A BEAM AND PLASMA. G. S. Kino and R. Gerchberg (Stanford Univ., Calif.). Phys. Rev. Letters; 11: 185-7(Sept. 1, 1963).

The electron beam–plasma interaction in which an initial r-f deflection of the beam increases in amplitude as the beam passes through the plasma is considered. Theory is presented that predicts a whole class of interactions with azimuthally varying fields for which growing waves occur, not only near the electron plasma frequency but also near the ion plasma frequency. An experiment demonstrating deflection amplification at frequencies near the electron plasma frequency is reported. (C.E.S.)

1142 EXISTENCE OF MIRROR MACHINES STABLE AGAINST INTERCHANGE MODES. Harold P. Furth (Univ. of California, Livermore). Phys. Rev. Letters, 11: 308-10 (Oct. 1, 1963).

The existence of a wide class of poloidal vacuum-field configurations where the magnetic field has a finite local minimum value on a circle is pointed out, and this phenomena is related to the existence of stable mirror machines. (C.E.S.)

1143 rf PROPERTIES OF THE PLASMA SHEATH. R. S. Harp, G. S. Kino, and J. Pavkovich (Stanford Univ., Calif.). Phys. Rev. Letters, 11: 310-12(Oct. 1, 1963).

An experiment to determine the existence of self-oscillating r-f fields in the sheath of a plasma and to investigate how an externally applied r-f field penetrates through the sheath and into the plasma was reported. Both the r-f and d-c fields in the sheath were measured. The r-f results were in good agreement with self-consistent small-signal calculations of r-f field penetration into the sheath. The theoretical method used was to integrate the one-dimensional form of the collisionless Boltzmann equations by the orbital integration technique. (C.E.S.)

1144 OPERATION OF A COAXIAL PLASMA ACCELERATOR. John Elbert Nankivell. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1963. 109p.

The operation of an electrode-type coaxial plasma accelerator, with a large ratio of outer conductor radius to inner conductor radius, was experimentally investigated, and the results indicate that none of the usual models, slug, snowplow, and shock, correspond with the results. The velocities attained were in all cases considerably lower than predicted from the actual currents. H, He, Ar, and N were used, both by injection into the accelerator through a fast-acting valve and as a uniform initial gas distribution. Results of current-front position vs time are presented as functions of the various parameters. The shape of the leading surface of the current front was measured with probes, and the luminous plasma was photographed. The current distribution in the front was determined from magnetic probe measurements. (Dissertation Abstr.)

1145 LONGITUDINAL INSTABILITIES OF RELATIVISTIC BEAMS IN AXIALLY SYMMETRIC MAGNETIC FIELDS. Ronald W. Landau. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1963. 133p.

A canonical formalism is developed for the description of the negative mass instability (N.M.I.) and longitudinal oscillations of relativistic beams. The formalism is used to ascertain the stabilizing effect of betatron oscillations, and to determine the dispersion relation governing counter-streaming ions and relativistic electrons. The results show that only the spread in p_θ, the canonical angular momentum of the particles, contributes to stability. The N.M.I. equation for 2 streams is the same as though each were separately present; and the dispersion relation for longitudinal oscillations of beams in a magnetic field is given by the N.M.I. dispersion relation, and not by the dispersion relation for longitudinal oscillations of collinear beams. Moreover, the dispersion relation for longitudinal oscillations of thin collinear beams differs from the usual equation by a non-trivial factor. (Dissertation Abstr.)

1146 FIZIKA PLAZMY I PROBLEMY UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA. DOKLADY VTOROI KONFERENTSII PO FIZIKE PLAZMY I PROBLEME UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA, KHARKOV, 14-19 NOYABRYA 1960g. (Plasma Physics and Problems in Controlled Thermonuclear Synthesis. Reports of the Second Conference on Plasma Physics and Problems in Controlled Thermonuclear Fusion, Kharkov, Nov. 14-19, 1960). K. D. Sinel'nikov, ed. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 1-343(1963).

Thirty-five papers are included on problems of high-frequency plasma, interactions of charged particles with plasma, magnetohydrodynamic and shock waves in plasma, plasma clusters, magnetic traps, gas discharge and strong pulse techniques, and plasma diagnostics. Separate abstracts have been prepared for 24 papers; 11 papers were previously abstracted in NSA. (R.V.J.)

For abstracts of individual papers see: 483, 513, 1147, 1148, 1149, 1150, 1151, 1152, 1153, 1154, 1155, 1156, 1157, 1158, 1159, 1160, 1161, 1162, 1163, 1164, 1165, 1166, 1167, and 1168.

1147 EXCITATION AND ABSORPTION OF ION CYCLOTRON OSCILLATIONS IN PLASMA. M. P. Vasil'ev, L. I. Grigor'eva, B. I. Smerdov, and V. V. Chechkin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 9-15(1963). (In Russian)

Induction of high frequency energy into a dense plasma near ion cyclotron resonance was tested and compared with Stix coil induction. A qualitative agreement was found for experimental and theoretical results on ion cyclotron excitation dispersion in plasma with charged particle radial density gradients. (R.V.J.)

1148 INFLUENCE OF RADIATION EFFECTS ON ELECTRON PLASMA RELAXATION IN STRONG MAGNETIC FIELD. A. I. Akhiezer, V. F. Aleksin, V. G. Bar'yakhtar, and S. V. Peletminskii. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 15-28(1963). (In Russian)

Thermal equilibrium in plasma is ordinarily determined by kinetic equations that consider only Coulomb interactions. Relaxation times determined by electron collisions grow in proportion to the cube of the electron thermal velocity and reach high magnitudes at high temperatures. An attempt was made to study other possible mechanisms in thermal equilibrium stability. It is shown that electromagnetic wave emission and absorption by plasma electrons in strong magnetic fields strongly influence thermal equilibrium and can contribute to the absolute equilibrium of a transverse electron component at nonrelativistic temperatures ($T \ll m_0c^2$, where m_0 is electron mass) and of transverse and longitudinal electron components at relativistic temperatures ($T \geq m_0c^2$). Radiative effects do not influence the relaxation of an angular variable in the transverse component plane, neither the nonrelativistic longitudinal component nor the angle between the plane and the magnetic

field in an extreme relativistic case. Photon relaxation simultaneous with electron relaxation rapidly establishes a quasi-equilibrium photon distribution. The quasi-equilibrium distribution slowly (during complete electron relaxation) reaches equilibrium (Rayleigh-Jeans distribution near the emitting line). (R.V.J.)

1149 MAGNETIC DELAY OF PLASMA ELECTRON EMISSION. V. I. Pakhomov, V. F. Aleksin, and K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 40-70(1963). (In Russian)

Kinetic theory was used in determining energy losses of nonrelativistic electrons in motion along a plasma spiral. It was assumed that the mean thermal electron velocity, $v_T = \sqrt{T/m}$, is considerably less than the velocity of light. General expressions were developed for electron-produced electric and magnetic fields. Equations developed for the intensity of single electron emission were used for determining plasma of the absorption properties for frequencies near ω_s. (R.V.J.)

1150 ON ELECTRON EMISSION UNDER PLASMA RESONANCE CONDITIONS. V. I. Pakhomov and K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 70-9(1963). (In Russian)

Magneto-delayed electron emission at double-resonance was studied, and Cherenkov emission by fast plasma electrons was evaluated considering the absorption factor. It is shown that under double-resonance conditions the intensity of magneto-delayed electron emission, with mean thermal electron velocity v_t, increased as $(1/\beta^{s+1})$, where $\beta = (v_t/c)$, $s = 3,4 \ldots$ is emission intensity in a vacuum. (R.V.J.)

1151 INTERACTIONS OF ELECTRON BEAMS WITH MAGNETIC FIELDS. I. F. Kharchenko, Ya. B. Fainberg, R. M. Nikolaev, E. A. Kornilov, E. I. Lutsenko, and N. S. Pedenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 118-27(1963). (In Russian)

Instability increments and energy exchange between interacting electron beams and plasma in a magnetic field are investigated. (R.V.J.)

1152 ON INTERACTIONS OF CHARGES WITH ELECTRON PLASMA IN MAGNETIC FIELD. A. B. Kitsenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 127-32(1963). (In Russian)

Energy losses of charged particles in motion along the lines of an external magnetic field were estimated for the case in which the particle velocities exceed the thermal velocities of plasma electrons. An analysis was also made of the coherent emission produced by a spherically symmetric cluster passing through magneto-active plasma. (R.V.J.)

1153 CHARGED PARTICLE BEAM PASSAGE THROUGH MAGNETOACTIVE PLASMA. A. B. Kitsenko and K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 144-56 (1963). (In Russian)

The influence of an anisotropic distribution function on particle beam excitation of slow electromagnetic waves was investigated. The cyclotron excitation of fast electromagnetic waves is considerably weaker than cyclotron excitation of slow waves, thus the studies were confined to the excitation of slow waves. Dispersion equations were developed for dielectric penetrability, longitudinal oscillations, and quasilongitudinal propagation. (R.V.J.)

1154 INTERACTIONS OF ELECTRIC OSCILLATOR BEAMS WITH PLASMA IN MAGNETIC FIELD. V. I. Shevchenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 156-63(1963). (In Russian)

An analysis was made of interactions between electric oscillator fluxes, moving at a constant rate and rotating with identical velocities in a plane perpendicular to the magnetic field, and unrestricted plasma in a constant magnetic field. Equilibrium electron beam and plasma charges are compensated by positive ion charges. The analysis was confined to high-frequency electron oscillations. (R.V.J.)

1155 ON THE INSTABILITY OF LONGITUDINAL PLASMA OSCILLATIONS IN STRONG ELECTRIC AND MAGNETIC FIELDS. K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 164-6(1963). (In Russian)

Instability of longitudinal oscillations in a rarefied plasma in a strong electric field distributed parallel to the external magnetic field was analyzed in linear approximation. (R.V.J.)

1156 ON STABILITY OF LONGITUDINAL LARGE-AMPLITUDE WAVES. V. D. Shapiro. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 166-75(1963). (In Russian)

Stationary oscillations of large-amplitude longitudinal waves were analyzed, and theoretical equations were developed for stable nonlinear oscillations in relation to long-wave perturbations with wave lengths considerably shorter than the stationary potential wave length. (R.V.J.)

1157 ON THE DEVELOPMENT OF EVOLUTIONARY MAGNETOHYDRODYNAMIC FLOW. R. V. Polovin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 184-90(1963). (In Russian)

Continuous stationary flow and conditions of evolutionary magnetohydrodynamic flow were analyzed. An accelerated flow through a phase velocity was considered evolutionary and attenuated flow nonevolutionary. (R.V.J.)

1158 EXOTHERMAL AND ENDOTHERMAL INTERRUPTIONS IN MAGNETOHYDRODYNAMICS. R. V. Polovin and V. P. Demutskii. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 190-6(1963). (In Russian)

Possible detonation, combustion, and ionization conditions (due to shock heating) in magnetohydrodynamic media were discussed. (R.V.J.)

1159 ON MAGNETOHYDRODYNAMIC EQUATIONS. R. V. Polovin and K. P. Cherkasova. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 196-218(1963). (In Russian)

Hydrodynamic equations were developed for charged and neutral particle plasmas. Ohm's law in first approximation, equations for two-component plasma, and stationary-body streamlining were analyzed. (R.V.J.)

1160 ELECTRODYNAMIC ACCELERATION OF PLASMA CLUSTERS. I. T. Guzhovskii, A. F. Krivonos

and B. G. Safronov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 219-23 (1963). (In Russian)

Experimental installation of a conical plasma source and vacuum chamber capable of producing plasma clusters with velocities exceeding 10^7 cm/sec is described. The plasma cluster velocities as a function of condenser bank potential for a source with a reverse conductor and a source with a spiral reverse conductor were analyzed. The results showed that a spiral reverse conductor increases cluster velocity. Electric probe measurements showed that at 16 kw the average number of ions in a cluster was 5×10^{15} cm^{-3} at the source and 5×10^{11} cm^{-3} at 70 cm from the source. The reverse spiral conductor produced a velocity of 3×10^7 cm/sec, indicating a potential for producing deuterium or tritium clusters with velocities exceeding 3×10^7 cm/sec. (R.V.J.)

1161 ON THE ACCELERATION OF PLASMA CLUSTERS FROM A COAXIAL SOURCE. A. M. Kovalev. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 228-31(1963). (In Russian)

General aspects of electrodynamic equations for coaxial sources suggest that the plasma cluster injection rate is determined by the source length along with other factors. However, experiments showed that the cluster velocity is not a function of source length. An attempt was made to find the reason for such unexpected experimental results. (R.V.J.)

1162 INVESTIGATION OF PLASMA MOTION IN A COAXIAL SOURCE. A. M. Kovalev. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 231-7(1963). (In Russian)

Experimental studies of plasma cluster acceleration from coaxial sources showed that cluster velocities increase with increased source potential. The velocity of constant-mass clusters is proportional to $\sqrt[4]{(v_0^2/m)}$ and the velocity of variable-mass clusters is proportional to $\sqrt[4]{(v_0^2/m_0)}$. In coaxial sources with identical parameters, acceleration of constant-mass clusters is about twice as effective as acceleration of variable-mass clusters. (R.V.J.)

1163 INTERACTIONS OF PLASMA CLUSTERS WITH EXTERNAL MAGNETIC FIELDS. N. A. Khizhnyak and B. G. Safronov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 238-75 (1963). (In Russian)

Interactions of plasma clusters with external magnetic fields were analyzed considering the nature and dimensions of the clusters. Equations were obtained for longitudinal motion, transverse constriction, and rotational motion. Cluster self-induction, conduction, moments, and interactions with corkscrew fields are discussed. Cluster reflection and capture are described by stability equations for self-induction and field interactions. (R.V.J.)

1164 INVESTIGATION OF ELECTRODELESS DISCHARGE IN MAGNETIC TRAPS. Ya. F. Volkov, V. T. Tolok, and K. D. Sinel'nekov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 276-83(1963). (In Russian)

An attempt was made to transform fast traps into slow ones for the purpose of extending plasma confinement in resonance fields. A programmed analysis was made of plasma confinement by magnetic field systems. Experiments were carried out with an azimuthal magnetic field, a hollow plasma cylinder, and a negative curved magnetic trap with a parallel coil distribution. Gamma radiation studies were made in order to confirm the induction mechanism of electron acceleration. The data suggest a betatron-type electron acceleration mechanism. (R.V.J.)

1165 SOME PROBLEMS ON CHARGED PARTICLE MOTION STABILITY IN STELLARATOR TYPE MAGNETIC FIELD. A. A. Sharshanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 287-95(1963). (In Russian)

Equations were developed for charged particle motion stability in an infinite spiral cylinder. (R.V.J.)

1166 DYNAMICS OF SELF-CONTAINING DISCHARGE IN MAGNETIC FIELD. V. A. Suprunenko, E. D. Volkov, N. I. Reva, E. A. Sukhomlin, P. Ya. Burchenko, and N. I. Rudnev. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 306-8(1963). (In Russian)

The m = 1 type instability was investigated using a system of nine magnetic probes in a discharge chamber. It was found that charge oscillation amplitudes along the chamber radius grow in proportion to the square root of the electric field intensity. The position, conductance, and current density of the charge at any arbitrary time or point were determined by magnetic probe signals. Photographic methods were unsuccessful due to interference produced by charge contact with the camera wall. (R.V.J.)

1167 PLASMA DIAGNOSTICS BY MEANS OF MULTIPLE FREQUENCIES. L. A. Dushin, V. I. Kononenko, and A. I. Skibenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 315-22 (1963). (In Russian)

Data were obtained on the electron density and collision frequencies in gas discharge at 9.25, 37, and 74 Hertz. (R.V.J.)

1168 INVESTIGATION OF ELECTRON SPATIAL DENSITY DISTRIBUTION BY MEANS OF MICROWAVES. L. A. Dushin, V. I. Konenko, and A. I. Skibenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Vtoroi Konf., Kharkov, 1960, No. 2, 322-8(1963). (In Russian)

Spatial distribution of electrons in a hot plasma was determined by measuring microwave interactions and adhering to strict geometric optics $a \gg \lambda$ (where a is plasma dimension and λ the microwave length). Spatial distribution as a function of attenuation and collision frequencies was measured at 37 and 74 Mc. Oscillograms of reflected signals are included. (R.V.J.)

Shielding

1169 (AD-289349) GAMMA RAY ATTENUATION IN A 12-INCH DIAMETER ROUND CONCRETE DUCT. T. R. Fowler and C. H. Dorn (Naval Civil Engineering Lab., Port Hueneme, Calif.). Nov. 5, 1962. 30p.

Dosimeter and Geiger tube measurements were made along the centerline of a 12-inch diameter circular concrete duct with two right-angle bends. Measurements showed that the build-up factor in the first leg was the

same as that found in earlier work for the square duct. As with the square duct, the dosage received down one leg of the duct follows closely the functional form Kx^{-m}, where x is the distance along the axis of the duct, and K and m are empirical constants. The value of m for a round duct was found to be about 10% smaller than that found for square ducts of similar size. The attenuation of the corner, however, is greater for a round duct than for a square one. A theoretical treatment of the first leg using single-scattering theory is included. (auth)

1170 (AEET/HP/TH-4) A GRAPHICAL METHOD OF GAMMA RAY SHIELDING CALCULATIONS. C. M. Sunta (India. Atomic Energy Establishment, Trombay). 1963. 25p.

A procedure is developed for calculating the shield thickness necessary to reduce the dose rate from a given gamma flux to a desired value. The method is applicable to any shielding material and gamma rays of any energy of practical interest. (D.C.W.)

1171 USE OF LEAD GLYCEROLS FOR HIGHLY EFFECTIVE BIOLOGICAL SHIELDING. E. Fumagalli. Energia Elettrica, 40: 559-65(July 1963). (In Italian)

Conglomerates with high shielding effectiveness employing organic binders, particularly suitable for applications in research reactors and means of transport were studied. It appeared that cements based on lead glycerols could be used for this purpose. It was deemed advisable to correct the shielding action of lead by the addition of iron. Conglomerates that can actually be used are defined and experiments were carried out in order to ascertain physical and mechanical characteristics. (TCO)

1172 A SIMPLE METHOD FOR DETERMINING LEAD EQUIVALENTS. E. Becker and F. Vorsprach (Institut für Werkstoffkunde und Werkstoffprüfung, Magdeburg, Ger.). Kernenergie, 6: 509-13(Sept. 1963). (In German)

The influence of narrow and broad radiation bunches on the measurement results were investigated. Since the determination of the increment factors necessary for calculation of the lead equivalents is in general difficult, a simple experimental method is proposed. With film absorption lead equivalents for any material could be ascertained easily. (tr-auth)

1173 TOTAL ATTENUATION COEFFICIENTS OF 5-11 Mev GAMMA RAYS. Robert Howard Barlett. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 73p.

The attenuation of neutron-capture γ rays in Be, Al, Cu, Sn, and Pb was measured at energies of 5.44, 6.40, 7.73, and 10.83 Mev. Absorption of thermal neutrons from a reactor by different elements, with the subsequent emission of photons, provided the monoenergetic γ-ray source. An intense well-collimated photon beam allowed uncertainties to be held down to 0.3% to 0.5%. From the ratio of photon intensity with the absorber in the beam to the intensity with no absorber in the beam, the absorbers attenuation coefficient was calculated using the exponential absorption law. Measurements of total attenuation coefficients are within the estimated uncertainty of theoretical predictions. The cross section for pair production in the Coulomb field of the electron is deduced from the total attenuation measurements for Be and Al, after subtracting the theoretical Compton cross section. By subtracting this result and the Compton scattering cross section from the measured attenuation, the cross section for pairs created in the Coulomb field of the nucleus was obtained. Because of the good agreement between experiment and theory for the nuclear pair cross section for Be, a search was made for the possible reasons for the 1% difference between experiment and theory for the total cross section. Since 90% of the attenuation in Be occurs by Compton scattering, this difference is most easily accounted for by a 1% increase in the Compton cross section. This increase could be attributed to higher-order corrections to the Klein-Nishina law, which are neglected in theoretical calculations. (Dissertation Abstr.)

REACTOR TECHNOLOGY

General

Refer also to abstract 454.

1174 (AEEW-R-296) OUTPUT OF THE TYPE 4051 AND 4061 PERIOD METERS DURING STARTUP TRANSIENTS. J. D. Cummins (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). May 1963. 45p.

A digital computer program for the Ferranti Mercury computer is described. With this program, startup transients for the recently developed period meters, Types 4051 and 4061, may be computed. The reactivity disturbances considered are steps and terminated ramps of reactivity. Due allowance is taken of the variable time constant which is a feature of these period meters. The reactor may be critical or subcritical initially as desired, and the initial input time constant of the period meter may be zero or finite. Some representative transients obtained with the program are presented and discussed. (auth)

1175 (EURAEC-504) HEAT TRANSFER AND STABILITY STUDIES IN BOILING WATER REACTORS. Quarterly Progress Report VII, July 1, 1962–October 1, 1962. (Eindhoven, Netherlands. Technische Hogeschool). Work Performed under United States–Euratom Joint Research and Development Program. Contract 032-60-11-RDH. 23p. (WW/R-24)

Difficulties were encountered using the preheater in the subcooler circuit. The Thermocoax heating element extension outside of the flange has to be cooled at higher preheater powers up to 15 kw. Preparations were made for the installation of the forced circulation circuit. The pump was installed. Serious difficulties with the photomultipliers arose when using the scintillation counters for the void fraction measurements. It appeared that the photocathode including the conducting layer of silver of the photomultipliers had disappeared. Measurements of the cathode and anode current showed that overloading of the photomultipliers had not taken place. New photomultipliers did not give difficulties. Improvements were made to the scalar and mixing unit. The low frequencies in the signal of the flow rate was caused by small amounts of air in the circuit especially in the needle valves. The method of filling was improved to avoid the trapping of air. Hydraulic instabilities during boiling were recorded by feeding the signals from the burn-out detector and differential pressure gauge to a Visicorder. The data were then fed into a digital computer which calculated the auto-correlation functions and power density curves. The results show a marked oscillation of 0.4 cps in addition to oscillations of lesser amplitude around 1 cps. A new mathematical model was programmed for the IBM computer for static hydraulic calculations incorporating both subcooled boiling and the effect of the change in saturation temperature with height. (auth)

1176 (GEAP-4309) SODIUM-COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Seventh Quarterly Report, April–June 1963. F. J. Leitz, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1963. Contract AT(04-3)-189. 85p.

Sodium logging tests were completed on three mixed oxide fuel specimens. In oxide fuel-sodium compatibility tests conducted at 1050 to 1200°F, negligible reaction was observed with stoichiometric UO_2 of density greater than 89% of theoretical, pellet disintegration was observed with hyperstoichiometric UO_2. Slight grain boundary attack was observed on irradiated mixed oxide fuel. Fabrication of fuel specimens for fission product plugging and release studies is nearly completed. Testing of mixed oxide fuel specimens in GETR and TREAT is reported. Fast flux irradiation of fuel specimens in EBR-II is discussed. Preoperational testing of the central temperature measurement capsule is being evaluated. Feasibility of evaporating thin layers of oxide on mixed oxide pellets was demonstrated as a means for depositing plutonium-242 traces for planned plutonium migration studies. Sampling of fuel by ultrasonic drilling was successful. Control of mixed oxide fuel pellet stoichiometry during sintering was shown to be achievable by adjusting the water vapor content of the 6% H_2-94% He sintering furnace gas. Parametric studies were made on several different core compositions and geometries for a large FCR with diameter to height ratios of 2, 3, and 6. Evaluation of the plutonium-239 Doppler effect was made using the multilevel method with results in close agreement with those previously obtained using the single level method. (N.W.R.)

1177 (NP-13264) WIND TUNNEL TESTS OF GAS DIFFUSION FROM A LEAK IN THE SHELL OF A NUCLEAR POWER REACTOR AND FROM A NEARBY STACK. Report No. 63-2. James Halitsky, Jack Golden, Paul Halpern, and Paul Wu (New York Univ., New York. Coll. of Engineering). Apr. 1, 1963. Contract Cwb-10321. 64p.

Tests were conducted in the NYU $3\frac{1}{2} \times 7$ ft low speed wind tunnel to determine the distribution of gas concentrations resulting from a gas leak in the shell of an industrial nuclear power reactor. The shell was patterned after the EBRII reactor at the NRTS at Idaho Falls. The basic tests were made on the shell alone in an adiabatic atmosphere having a logarithmic velocity profile corresponding to an average profile at NRTS. Additional tests showed the effect of a uniform velocity profile, change of absolute wind velocity, inclusion of auxiliary buildings, and heating the shell. The effect of proximity of the stack top to the shell was studied briefly. (auth)

1178 (STL-6309) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending September 30, 1963. L. B. Wentz and S. M. Zivi (Space Technology Labs., Inc., Redondo Beach, Calif.). Oct. 15, 1963. Contract AT(04-3)-372. 23p.

Additional measurements were made of steam-void fraction, temperatures, and pressures in the KEWB capsule experiment. Analysis of data indicated that friction in the volume transducer piston was large during most of the transients. The dynamic piston friction was reduced to negligible magnitudes. A method for calculating the transient heat flux from the fuel disc was formulated. Boiling stability experiments were begun with a 2-ft-long rod bundle, consisting of a square array of 16 stainless-steel rods 0.250-in. dia, spaced on 0.312-in. centers. The rods are electrically heated in a natural-circulation loop, at one atmosphere pressure. A survey was begun on theories and data on hydrodynamic instabilities in natural-circulation boiling systems. Preparation of apparatus for measurement of flow-void transfer functions in a SPERT IA channel was essentially completed. (M.C.G.)

1179 STABILITY IN THE LARGE AND BOUNDEDNESS OF SOME REACTOR MODELS. H. B. Smets (OECD, European Nuclear Energy Agency, Paris). J. Nucl. Energy, Pt. A & B, 17: 329-40(Oct. 1963).

Properties of stability in the large and boundedness for nuclear reactor power are derived in the cases where the power reactivity transfer function is characterized by one pole, one zero-one pole, one zero-two poles, two zeros-two poles; two zeros-three poles by means of Welton's criterion, Liapounoff's Second method and the boundedness theorem. Examples of application to homogeneous and heterogeneous reactor models are worked out in detail. (auth)

1180 ON THE DERIVATION OF A VARIATIONAL PRINCIPLE FOR LINEAR SYSTEMS. D. S. Selengut (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 17: 310-11(Oct. 1963). (TID-18628)

A specified physical system, such as a reactor, whose state is described by a function of the relevant phase space coordinates is considered. A derivation is outlined that enables one to take a given linear theory and immediately obtain a lagrangian whose stationary property is equivalent to the equations of the theory and that constitutes a variational principle for the estimation of an arbitrary linear functional of the state of the system. (C.E.S.)

1181 SHUTDOWN HEAT GENERATION. J. G. Delene. p.40-2 of "Nuclear Safety. Vol. 5, No. 1."

Information on shutdown heat generation is reviewed. The total fission-product energy release and time behavior are discussed. Sources of heat after shutdown other than fission products are described. (M.C.G.)

1182 REVIEW OF KEWB PROGRAM. J. H. Marable. p.42-5 of "Nuclear Safety. Vol. 5, No. 1."

The KEWB (kinetic experiments on water boilers) program to provide design data for ensuring maximum safety and to develop reliable analytical methods for predicting the dynamic behavior of solution type reactors was completed. The experiments are described, and a model for kinetic behavior is presented. (M.C.G.)

1183 REACTOR SELF-SHUTDOWN MECHANISMS. R. S. Stone. p.64-8 of "Nuclear Safety. Vol. 5, No. 1."

Self-shutdown of reactors is discussed. A continuing program of SPERT experiments demonstrated that water-moderated reactors have self-limiting mechanisms that arise from fuel expansion, moderator expansion, and steam-void formation. The mechanisms were shown to be capable of reversing a 10- or 20-msec period before core damage occurs. The experiments also showed that for the reactivity additions used in these tests, a fast electrochemical system was capable of holding the peak power to considerably lower values than allowed by self-shutdown. Investigations of potential shutdown mechanisms are described. (M.C.G.)

1184 THE JOINT RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY DIGEST, VOL. 3, NO. 2, APRIL 1–JUNE 30, 1963. (United States–Euratom Joint Research and Development Program). 90p. $5.00 per yr. (Euratom). (TID-19575)

A cumulative list is presented of the contracts entered into force before June 30, 1963. The programs contracted during the report period are also described. Technical progress during the report period is reported in detail for the programs in nuclear fuels, reactor materials, nuclear engineering, reactor physics, and miscellaneous. A list of progress reports and other publications is included. (D.L.C.)

Auxiliaries and Components

1185 (ARF-8262-3) STUDIES OF REACTOR CONTAINMENT STRUCTURES. Bi-Monthly Progress Report, N. A. Weil, R. L. Chiapetta, C. J. Constantino, P. G. Hodge, S. A. Morse, and M. A. Salmon (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Nov. 29, 1962. Contract AT(11-1)-578. 70p.

The development and design of reactor containment structures are studied. Information is given on: plastic deformation of membrane shells of revolution, a simplified shield-structure interaction problem, response of finite length cylinders to dynamic loads, the ultimate strength of a spherical gap with a rigidly reinforced opening, a theoretical study of the effect of circular openings on the plastic behavior of plates, bulging experiments on pressurized cylinders of finite length, and the development of a containment handbook for designers. (N.W.R.)

1186 (BMI-X-10062) A STUDY OF ROTARY SHAFT-SEALING CONCEPTS FOR PRESSURIZED-WATER REACTOR APPLICATION. Quarterly Progress Report for July–September 1963. C. Malcolm Allen and Daniel R. Grieser (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. 9p. (EURAEC-843)

Seals that can be used at 2500 psi and 600°F are being studied. The behavior of rotary face seals is being studied by means of an instrumented transparent model which allows direct observation of the fluid in the seal gap during operation. The seal apparatus was designed, constructed, and commissioned. Calibration of a capacitance-probe seal-gap-measuring system is being improved. Experimental observations have revealed microruptures in the seal interface water. The importance of stator distortion to the pressure-balance design of a seal was confirmed by laboratory measurement. A computer program for the calculation of seal distortion is under development. A packed-gland seal facility was commissioned. Experiments with a rotating packing geometry and a transparent outer sleeve have revealed operating conditions which lead to complete vaporization of the water in the seal interface. Destruction of a Teflon-asbestos packing material was observed visually. (N.W.R.)

1187 (CEA-2312) LES BETONS SPECIAUX DANS LA PROTECTION DES PILES. (Special Concretes for Protection in Reactors). M. J. Condat, P. Lafore, and J. Rastoin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 68p.

A review is presented of the main concretes used for the protection of reactors. First are examined the general factors affecting the selection of concretes for protection; some of the general aspects of radiation attenuation (fast and thermal neutrons, γ) are then recalled. After an enumeration of the qualities and defects of conventional concretes, desirable or possible improvements are proposed: introduction of heavy elements for increasing the efficiency with respect to fast neutrons and γ; increase in the hydrogen content (as H_2O), addition of absorbant products (B, Li, rare earths) for thermal neutron capture. A list is given of the principal products used for this purpose. Finally there is a rapid review of the preparation, the stability with time, and the resistance to radiation and to heat. Appendices and tables give details and numerical values. The appendices deal with the question of water in

concretes and give a classification of concretes based mainly on their density. At the end, ten tables give the compositions and values of the physical and mechanical characteristics of sixteen particularly typical concretes. (auth)

1188 (GNEC-299) DEVELOPMENT OF HYDRAULIC BALL (HY-BALL) CONTROL SYSTEM. Fifth Quarterly Progress Report, July–September 1963. (General Nuclear Engineering Corp., Dunedin, Fla.). Oct. 1, 1963. Contract AT(38-1)-207. 64p.

The physics analysis (including burnup effects and an approximation of the void-distribution effects) of the axial power distribution of a core, with the upper 5 feet having a higher U^{235} enrichment than the lower 5½ feet, was completed. A physics analysis (including burnup and void-distribution effects) of the axial power distribution of a core with an axial zone of distributed poison was completed, with the exception of burnup calculations. Lift and scram tests were run with satisfactory results on a promising type of buffer system, called the flow-control buffer. The first series of room temperature leakage tests and reactor temperature cycling tests was satisfactorily completed on two three-way control valves. The second and third series of tests on the Hy-Ball columns in the hot test loop were satisfactorily completed. The second series of tests consisted of holding the simulated control elements in the up position in stainless steel vertical tube hoppers (simulating the out-of-core position) for 500 hr. The third series of tests consisted of holding the simulated control elements in the down position (simulating the in-core position) for 1200 hr with Zircaloy tubing in the lower half of the Hy-Ball column assemblies. No vibration-induced wear and/or fretting corrosion of any significance and no sticking of control elements were observed. (auth)

1189 (HW-SA-3088) THE DEVELOPMENT OF MATERIALS FOR APPLICATION TO CONTROL ROD SYSTEMS IN GRAPHITE-MODERATED REACTORS. G. E. Wade and F. J. Kempf (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 3, 1963. Contract [AT(45-1)-1350]. 36p. (CONF-263-1)

For Presentation at International Atomic Energy Agency Symposium on Physics and Material Problems of Reactor Control Rods, Vienna, Nov. 1963.

Test and fabrication experience with control materials for graphite moderated tube type reactors indicated that a wide variety of satisfactory rod designs are possible using either boron which is integral with the control rod sheath or B_4C graphite and sintered B_4C–aluminum within metallic rod sheaths. The control effectiveness of tubular boron stainless steel rods can also be increased by filling the interior of the rod with sintered B_4C. Materials such as Al_2O_3, graphite, and pyrolytic carbon (PyC) graphite or PyC impregnated carbonized hemp, jute, or graphite felt provide rod channel liners with a wide range of strength and deflection characteristics. In order of preference for channel liner applications, graphite or PyC-impregnated graphite are first from the standpoint of acceptable nuclear characteristics and cost. In those portions of the rod channel where load resisting capacity is required greater than that provided by graphite, Al_2O_3 liners are acceptable. The economic penalties of added enrichment costs associated with installation of relatively thick walled Al_2O_3 liners can be minimized or at least reduced by placement of these liners only in portions of the rod channel where the very high strength material is required. (auth)

1190 (NYO-10575) QUARTERLY PROGRESS REPORT ON EVALUATION OF AUTOMATIC FLOW BALANCING DEVICE IN BOILING WATER REACTORS, JULY–SEPTEMBER 1963. Report No. 427. R. L. Mela, D. A. Gall, and E. F. Doyle (Dynatech Corp., Cambridge, Mass.). Oct. 15, 1963. Contract AT(30-1)-2907. 11p.

The high-pressure loop control system is described. Progress on the fabrication and assembly of the test section and loop are discussed. A schedule for the completion of the program is discussed. (auth)

1191 (PAN-375/XII) ANALIZ NEKOTORYKH PROEKTNO-ISSLEDOVATEL'SKIKH VOPROSOV. AVTOMATICHESKOGO REGULIROVANIYA YADERNYKH REAKTOROV. (Some Design Problems of Reactor Control Systems). V. Filipchak (Polish Academy of Sciences. Inst. of Nuclear Research. Warsaw). Dec. 1962. 42p.

Some design problems of control system of nuclear reactor are analysed. In the first, more theoretical part of this report, some design criteria for reactor control system e.g. the speed and nuclear weight of control rod, the control system static and dynamic quality, the maximum torque of driving motor are analysed. In the second part, there are experimental results of checking out by the method of combined simulation of two different control systems: a/ s.c. "EWA" control system (containing the amplidyne and 120 w d-c motor), b/ s.c. "ANNA" control system containing one of the a-c micromotor (0.67; 2.4; 4.6 w) and magnetic amplifier. (auth)

1192 (AEC-tr-6108) HOLES IN THE SHIELD OF A REACTOR FORMULARY PROJECT. C. Devillers (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP-230/62. July 1962. 27p.

The principal problems concerning the leakage of radiation through the holes (heat transfer ducts, etc.) of a reactor shield are outlined. Radiation sources and the design and leakage properties of cooling ducts and charging shafts are discussed. Methods for calculation of the types of propagation (direct, reflected, and transmitted) are reviewed, and some typical experimental values for gammas and neutrons are given or cited. Application of the methods to shields of graphite and CO_2 gas reactors is also considered. 38 references. (D.C.W.)

1193 (AEC-tr-6111) CALCULATION OF THE SHIELD FOR "BEPO" AND CALDER HALL. G. Brandicourt and F. Le Berre (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). Translated for Oak Ridge National Lab., Tenn., from report DEP/SEPP-224-62. [1962]. 29p.

The neutron flux and the doses due to capture gamma rays in the side shields of the Calder Hall and BEPO reactors were calculated. The methods and calculation programs utilized are summarized. Results are presented in tables and graphs. (M.C.G.)

1194 SOME DESIGN ASPECTS OF ELECTRONIC REACTOR SIMULATORS. T. L. Canning and R. J. Churchill. Electron. Eng., 34: 168-72(Mar. 1962).

Electronic reactor simulators are used extensively for research and training purposes. General design considerations are given, and it is shown how, in certain conditions, the computer complexity may be reduced by justifiable simplifying assumptions. A simulator design is suggested, incorporating a reactor kinetics section, a reactivity computer, and reactivity power coefficient analogs. The xenon poison computer is recommended as a separate element

operating on a fast time scale. Some simulator applications encountered in reactor control studies are given. These include reactor frequency response and xenon poison transients. (auth)

1195 ON THE ASYMPTOTIC FORM OF THE COLLISION DENSITY. C. A. Wilkins (Univ. of Auckland, N. Z.). Nucl. Sci. Eng., 17: 220-2(Oct. 1963).

In a single-species system with similarly varying cross sections, it is commonly assumed that the collision density F(u) has the asymptotic form ke^{mu}, where m satisfies the equation $(1-\alpha)(1+m)-c(1-\alpha^{1+m})=0$. This is equivalent to assuming that the pole with greatest real part of the Laplace transform of F(u) occurs at the real root $m(\neq -1)$ of the last equation. It is shown, by the use of certain results in the theory of transcendental equations, that if z is any complex root of the equation, then irrespective of the values of α and c, Re $z < \min(-1,m)$. Finally the constant k in the assumed form of F(u) is determined exactly, in terms of m, by taking the residue at m of the Laplace transform of F(u). (auth)

1196 AUTOMATIC CONTROL OF A REACTOR BY MEANS OF MOVING DETECTORS. Pavel Kovanic (Nuclear Research Inst., Czechoslovak Academy of Sciences, Řež). Tech. Dig. (Prague), 5: No. 4, 3-10; 41(Apr. 1963).

A description is given of the mechanisms used in the completely automatic operation of the Czechoslovak experimental reactor VVR-S. The measuring systems and the systems for automatic control of the reactor power and period are described. (R.E.U.)

1197 REACTOR CONTAINMENT SYSTEMS. W. R. Gall. p.75-84 of "Nuclear Safety. Vol. 5, No. 1."

The performances of various reactor containment systems are reviewed, and the results of a comparative cost study are given. Multiple containment, pressure-suppression containment, containment by building structures, and underground containment are described. The economic analysis was made for boiling-water-reactor containment. (M.C.G.)

1198 THE GRAPHITE STRUCTURE. K. H. Dent, E. Long, and K. Prince. p.319-48 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The manufacture and machining processes for graphite, structure design and the effect of graphite properties on structure design, and instrumentation and monitoring of the core are outlined. (C.E.S.)

1199 COOLANT GAS CIRCUIT. G. Brown. p.349-93 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The general specifications and operating conditions of the coolant circuit in gas-cooled reactors are discussed. The pressure vessel, heat exchangers, ductwork systems, ancillary circuits, valves, and circulators are considered. Standards of cleanliness for the coolant circuit are outlined. (C.E.S.)

1200 SHIELDING. R. T. Ackroyd, A. Jackson, and R. A. Pearse. p.430-67 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Sources of radiation, shield arrangement, shield materials, and shield cooling are discussed. Calculational methods for estimating the amount of shielding to produce the required attenuation are presented. (C.E.S.)

1201 REACTOR INSTRUMENTATION. R. H. Campbell. p.493-518 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Three groups of reactor instrumentation are discussed including safety and protection, operational information, and design information instrumentation. Methods for measuring temperature, coolant flow, pressure, power, and neutron flux are outlined. Burst fuel element detection is also considered. (C.E.S.)

1202 REACTOR CONTROL. R. H. Campbell. p.519-52 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Power control, control rods, drive mechanisms, secondary shut-down, automatic control, and the reactor transfer function for the gas-cooled graphite-moderated reactor are discussed. (C.E.S.)

1203 ELECTRIC POWER SUPPLIES. N. J. Mackay. p.553-84 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The electric power requirements, the electrical system and its governing features, the emergency system, and the electrical distribution are outlined for the gas-cooled graphite-moderated reactor. (C.E.S.)

1204 IMPROVEMENTS RELATING TO BURST SLUG DETECTION DEVICES IN NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). First Add. No. 75,732 to French Patent 1,201,566. June 26, 1961. Filed May 19, 1959.

A device was previously developed in which some radioactive daughters of the gaseous fission products formed inside the nuclear fuel slugs are detected in the gaseous coolant in the case of a burst slug. Samples of gaseous coolant are taken from the different reactor channels by a system of sampling lines leading them to the detection device comprising a chamber in which, during a certain period, the radioactive daughters are electrostatically precipitated onto a zone of the cylindrical surface of a drum shaped electrode; after this period the electrode rotates about a given angle for bringing the zone in front of a scintillation counter. Improvements were made by mounting the drum in a cavity bounded by two metallic blocks between them is disposed a toroidal sealing ring for ensuring gas tightness. The rotation of the drum is controlled by an electric motor via a gear and a magnetic coupling transmitting a rotation movement via the wall of the cavity to the axle of the drum. (IIB)

1205 IMPROVEMENTS RELATING TO BURST SLUG DETECTION DEVICES IN NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). Second Add. No. 76,538 to French Patent 1,201,566. Sept. 25, 1961. Filed Nov. 13, 1959.

A device was previously developed in which some radioactive daughters of the gaseous fission products formed inside the nuclear fuel slugs are detected in the gaseous coolant in the case of a burst slug. Samples of gaseous coolant are taken from the different reactor channels by a system of sampling lines leading them to the detection device comprising a drum shaped electrode onto which the radioactive daughters are precipitated; afterwards this drum rotates for bringing them in front of a scintillation counter. In order to increase the period between two successive utilizations of the same precipitation zone on the drum's surface, the drum has on its surface in the direction of its rotation axis a large number of different parallel series of precipitation zones. These zones are successively brought in front of the precipitation chamber and the scintillation counter respectively by two kinds of movement.

The first movement is a translation of the drum in the direction of its axis. The translation is suitably alternating with different amplitudes in the two opposite directions. The second movement is a rotation changing over to an adjacent series of collection zones. (IIB)

1206 IMPROVEMENTS RELATING TO BURST SLUG DETECTION DEVICES IN NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). Third Add. No. 76,765 of French Patent 1,201,566. Oct. 23, 1961. Filed Nov. 18, 1959.

A device was previously developed in which some radioactive daughters of the gaseous fission products formed inside the nuclear fuel slugs are able to be detected in the gaseous coolant in the case of a burst slug. Samples of gaseous coolant are taken from the different reactor channels by a system of sampling lines leading them to the detection device comprising a drum shaped electrode onto which the radioactive daughters are precipitated; afterwards this drum rotates to bring them in front of a scintillation counter. Improvements were made so that each precipitation zone is brought in front of the counter before the precipitation in order to evaluate the activity of the zone, so that the difference between the two indications of activity of the same zone before and after the precipitation is proportional to the quantity of precipitated ions of the radioactive daughters. To increase this quantity the device comprises a precipitation chamber of increased volume through which the gas flow and in which the decay of the fission products into their daughters takes place. This chamber has a bell-mouthed shape, the smallest section of which is formed by the precipitation zone, while it is bounded at its largest section by a concave repulsion electrode. The remaining walls of the chamber are composed of an electrical insulating material. (IIB)

Crititicality Studies

Refer also to abstract 808.

1207 (HW-78706) TRIP—A REACTOR KINETICS CODE WITH PARAMETER SEARCH. W. L. Stiede and D. D. Matsumoto (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 21, 1963. Contract AT(45-1)-1350. 41p.

TRIP 005, the latest version of the TRIP program that solves the reactor kinetic equations, heat transfer equations, and several specialized instrumentation equations with respect to time, is described. The methods and theory used for the numerical solution of the differential equations in the program are explained, as well as the most recent modifications to the program. The TRIP program can determine, by iteration, the value of a specified parameter that will effect a given peak in a specified variable. (D.C.W.)

1208 (JAERI-1050) THE THERMAL NEUTRON SPECTRUM IN A MULTI-REGION SYSTEM (TNS CODE). Satoru Katsuragi and Reiko Saito (Japan Atomic Energy Research Inst., Tokyo). Aug. 1963. 19p. In Japanese.

The TNS CODE, an IBM 7090 FORTRAN code that calculates the thermal neutron spectrum at each position in a multi-region system and determines the thermal group constants, is described. In order to get the spectrum, the energy range concerned is divided into G groups, and the P_1 approximation is applied to calculate the neutron flux of each group. Finally, the G simultaneous differential equations are replaced with G simultaneous difference equations. The difference equations are solved directly without any iterations. The scattering kernel used in the code is based on the Brown model. Whether the region consists of light water, heavy water, or free gas, the TNS CODE gives the spectrum. Examples of calculations are shown for an enriched uranium heavy water homogeneous system. The results show significant variations of the effective absorption and fission rates in the system. (auth)

1209 (KAPL-M-JA-6(Rev.VI)) KARE INPUT. J. A. Archibald, Jr. and J. L. Fletcher (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 30, 1963. Contract W-31-109-Eng-52. 19p.

The iteration schemes used for the calculation of neutron fluxes within the KARE system are briefly described, and the revised KARE input is presented. Input for specific types of problems is considered. (D.C.W.)

1210 (KAPL-M-SW-3) CATALOGUE OF SHA EXPERIMENTS AND CALCULATIONS. S. Weinstein, R. Bobone, and F. Feiner (Knolls Atomic Power Lab., Schenectady, N. Y.). July 2, 1963. Contract W-31-109-eng-2. 49p.

The results of experiments performed to determine the critical configurations of a solid homogeneous assembly with an assortment of reflectors and internal neutron absorbers are presented. The configurations were represented in few group neutron diffusion models, and eigenvalue calculations were performed. The experiments and calculations are compared, and the effects of the nuclear data and computational model are discussed. (auth)

1211 THE THEORY OF RESONANCE INTEGRAL INTERACTION CORRECTION IN COMPACT FUEL-MODERATOR LATTICES. PART 2. NR APPROXIMATION. A. Mueller (VEB Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 6: 477-83(Sept. 1963). (In German)

In connection with earlier investigations on the principle of the simplified NRIA (narrow resonance infinitely heavy absorber) approximation, the influence of the reciprocal effects of the fuel block on the so-called surface term of the resonance integral in compact fuel-moderator lattices were investigated on the basis of the NR (narrow resonance) approximation. By use of an analytical approximation statement already given for the collision probability in regular lattices, the derivation of a relatively simple expression for the resonance integral was obtained. For calculation of the reciprocal effect factor, other approximation statements were consulted for comparison. A sufficiently exact and relatively simple approximation formula was obtained for the resonance integral on the reciprocal effect factor in the NR approximation for regular lattices of practical importance, if the corresponding exactly ascertained transmission probability for isotropic neutrons entering the moderator was used (Dancoff correction). A numerical comparison for plate lattices is included. The numerical calculation of the influence of potential scattering on the fuel atoms by the surface term of the resonance integral for isolated fuel blocks (plates, cylinders, spheres) could be drawn from the literature. A comparison of the reciprocal-effect factors or resonance integrals obtained by the NR and NRIA approximations is presented. (tr-auth)

1212 THE WIGNER-SEITZ CELL—A DISCUSSION AND A SIMPLE CALCULATIONAL METHOD. G. C. Pomraning (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 17: 311-14(Oct. 1963).

Existing calculational methods for the Wigner-Seitz cell approximation for the determination of the thermal flux distribution in a fuel element and its associated mod-

erator are discussed, and a new method is presented. The method employs a modified diffusion theory and appears to be quite accurate. The advantages of this method are discussed, and the results obtained are compared with existing methods. (C.E.S.)

1213 ACTIVITY BUILDUP IN PWR SYSTEMS. C. F. Baes, Jr. p.45-7 of "Nuclear Safety. Vol. 5, No. 1."

Trends in the study of activity-buildup processes in reactor systems are reviewed. Activity transport processes, buildup, and control are described. (M.C.G.)

1214 LATTICE CALCULATIONS FOR GRAPHITE-MODERATED THERMAL NEUTRON REACTORS. B. Cutts. p.635-62 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Equations and data are presented to enable estimates to be made of the major parameters for a graphite-moderated lattice containing uranium metal or uranium oxide fuel in the form of single rods, tubes, or clusters of rods. The parameters include fast fission factor, resonance escape factor, inverse diffusion lengths, fine structure, neutron spectrum, thermal utilization factor, thermal fission factor, lattice multiplication factor, diffusion area, slowing-down area, streaming factors, diffusion coefficients, xenon concentration, changes in isotopic content with irradiation, fission cross sections, heat production, and reactivity changes. (C.E.S.)

1215 GENERAL THEORY OF STABILITY. R. H. Campbell. p.666-80 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The degree of stability and the range over which adequate stability is maintained are considered for the control system of a gas-cooled graphite-moderated reactor. Several methods for the determination of stability are outlined. The methods include determination of roots of the characteristic transfer equation, Routh's criterion, Nyquist diagrams, and log gain-log frequency diagrams. (C.E.S.)

Fuels

1216 (BRB-75) DYNAPAK EXTRUSION OF MARK V-B OUTER FUEL ELEMENT CORES REPORT NO. 2. Q. C. Carloni and L. Lewis (Bridgeport Brass Co., Seymour, Conn.). Sept. 3, 1963. Contract AT(30-1)-1405. 44p.

The process to DYNAPAK extrude Mark V-B outer fuel element cores was studied further. Activity has involved efforts to extrude a double length core, secure acceptable die and mandrel materials, study various core characteristics, and check out new concepts pertinent to refining the process. Results indicated that substantial development is required in the area of extruding double length cores. Structures, dimensions, and surface quality show evidence of being able to conform to requirements specified for this core, but also require further attention. The process appears on its way to being finalized as either an alpha phase extrusion or alpha-phase extruded-beta-phase transformed route. (auth)

1217 (RISÖ-52) A THEORETICAL EVALUATION OF CRACK FORMATION IN UO_2-FUEL PELLETS AND ITS EFFECT UPON DOR-REACTOR FUEL ELEMENT DESIGN. B. Wedell (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1962. 87p.

A theoretical analysis of the stresses in the UO_2-fuel pellets, during start-up and operation of the DOR-reactor, leads to the concept of multifractured pellets which are "free" to expand thermally. This results in a relatively large initial pellet expansion causing the cold fuel to clad gap to vanish and creating large initial cladding stresses and strains in the hot zone of the DOR fuel elements. These initial start-up strains then remain constant until at a later stage fission gas pressures force the cladding further away, until finally "mechanical burnup" occurs, defined as the time when a set maximum cladding strain has been reached. (auth)

1218 (UCRL-6801) GROM—A TIME-DEPENDENT, ONE-DIMENSIONAL, MULTIGROUP NEUTRON DIFFUSION THEORY REACTOR BURNUP CODE FOR THE IBM 7094. G. M. Benson and E. T. Collins (California. Univ., Livermore. Lawrence Radiation Lab.). June 30, 1962. Contract W-7405-eng-48. 48p.

The computer program GROM, which calculates time histories of nuclear fission reactors with large fuel burnup and conversion ratios and high fission product removal rates, is described. The equations, operating instructions, and input are discussed; a sample problem is included. (D.C.W.)

1219 TABLES OF THE ESCAPE PROBABILITIES FOR HOLLOW CYLINDERS. H. Kiesewetter and H. Marbach (VEB Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 6: 483-9(Sept. 1963). (In German)

Tables are presented that contain the escape probabilities (of the first collision), calculated by the computer program HOZYSTO, on the outside or inside of hollow-cylinder jackets for the isotropic neutrons falling on the inside or outside and for constant, isotropic source distribution in the hollow cylinder. The escape probability with regard to the scattering could be determined approximately from this. The tables are, among other things, applicable for the calculation of hollow absorber rods and fuel-rod covers. (tr-auth)

1220 FUEL-ELEMENT FAILURE DETECTION. J. L. Kaufman. p.63-4 of "Nuclear Safety. Vol. 5, No. 1."

Developments in the detection of burst fuel elements are reviewed. A fast-gamma scanner is described. The performance of delayed-neutron monitors is also discussed. (M.C.G.)

1221 FUEL ELEMENTS. J. D. Waters and V. Walker. p.267-318 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The design of fuel elements is discussed with respect to heat transfer and mechanical strength. (C.E.S.)

1222 FUEL HANDLING. K. H. Dent. p.394-429 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

General principles for pre-irradiation fuel handling, charge and discharge operation, charge and discharge machinery, and post-irradiation fuel handling and transport are outlined. (C.E.S.)

1223 HYDRAULICALLY INDUCED DEFLECTION OF FLAT PARALLEL FUEL PLATES. Forrest Jerome Remick. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 124p.

As the velocity of the coolant flowing between flat parallel fuel-plate assemblies in nuclear reactors is increased beyond certain limits, the plates deflect to such an extent that the functional characteristics of the parallel-plate fuel assemblies are altered, and plate failure is possible. An analytical and experimental investigation was undertaken of

the hydraulically induced deflection of a single-plate fuel assembly in which an initial imperfection of the plate existed. The analysis resulted in a general expression for the static-pressure-difference profile axially along the fuel plate. Experimental tests were conducted in a special test assembly, in which initial plate imperfections were introduced. The theoretical and experimental results were found to be in excellent agreement. The resulting static-pressure profiles gave rise to a hypothesized source of vibration or plate flutter. The phenomenon of magnification of initial imperfections is discussed, and a criterion is established to determine whether the magnification will lead to plate failure. (M.P.G.)

Power and Power-Breeder Reactors

1224 (ACNP-61535(Rev.1)) HAZARDS ANALYSIS. RADIOLOGICAL HAZARDS. J. C. Courtney (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Aug. 31, 1962. Revised July 11, 1963. Contract AT(10-1)-925. 176p. (EGCR-STUDY-IV-313(Rev.1))

Doses were calculated for persons off site and in the EGCR control room following the maximum credible accident (depressurization), and for the public due to normal operational stack release. The assumptions and calculations used in the study are given in detail. (D.L.C.)

1225 (ACNP-63027) PATHFINDER ATOMIC POWER PLANT. Technical Progress Report, April–June 1963. (Allis Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Sept. 30. 1963. Contract AT(11-1)-589. 52p.

Progress in the development of the Sioux Falls Power Reactor is reported. Information is presented on: reactor physics of first core high-enriched boiler fuel elements; design and performance testing of in-core ion chambers, calibration wire, and monitoring system; testing and inspection of core components; irradiation testing of reactor vessel material; instrumentation development; and startup testing program. (N.W.R.)

1226 (ACNP-63029) INVESTIGATION OF VAPOR VOLUME FRACTION AND SLIP VELOCITY UNDER THE EURATOM PROGRAM. Quarterly Progress Report, July 1–September 30, 1963. Winfred A. Bezella, Mark Healy, Glenn J. Kangas, and Kenneth F. Neusen (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Oct. 10, 1963. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1272. 25p. (EURAEC-842)

A literature survey was performed in order to provide an adequate basis for selecting models for comparison with the data. A computer program was written that allows calculation of void profiles based on an exponential model. A variable exponent is input data for the program, which also computes an integrated average void fraction. After the test section installation was completed, shakedown tests were performed to assure that all equipment was operating properly. All water and all air reference traverses were run with the gamma attenuation equipment. The first two-phase run was accomplished at a superficial liquid velocity of one foot per second. (auth)

1227 (ACNP-63529) STEAM SYSTEM AND FEEDWATER SYSTEM FAILURES. S. Matovich, comp. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Dec. 20, 1961. Contract AT(10-1)-925. 173p. (EGCR-STUDY-IV-334)

The adequacy of the EGCR steam and feedwater systems for continued heat removal from the core was assessed for the following accidents: steam line failures, steam generator internal failures, and feedwater system failures. The reaction of the reactor coolant blowers and vessel cooling compressors to steam–helium mixtures was evaluated. The steam generator isolation systems are described. The containment system was found to be adequate to prevent activity release to the atmosphere in the event of all credible steam line or feedwater system failures. The design of the drum water level automatic isolation system does not prevent activity release during certain credible steam generator failures, however, this activity is released at the top of the plant stack and does not result in a dose which exceeds the acceptable yearly exposure. (M.C.G.)

1228 (AECL-1841) CHEMISTRY OF THE NPD HEAVY-WATER SYSTEMS. A. R. Bancroft, S. R. Hatcher (Atomic Energy of Canada Ltd., Chalk River, Ont.); and C. A. McKerlie (Ontario. Hydro-electric Power Commission, Rolphton). Oct. 1963. 10p. (CONF-243-6)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The chemistry of both heavy-water systems has been acceptable during NPD operation, except for a period following the December 3, 1962, incident. Recovery from this incident was rapid once reactor operation was resumed. (auth)

1229 (CEA-2309) PROSERPINE MASSES CRITIQUES EN URANIUM 235 ET ETALONS DE REACTIVITE. (PROSERPINE—Critical Masses with Uranium-235 and Reactivity Standards). J. Bertrand, J. P. Brunet, R. Caizergues, C. Clouet d'Orval, J. Kremser, and P. Verriere (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 43p.

The critical mass for the PROSERPINE reactor was measured as a function of the solution height in the tank, with various solution concentrations. A reactivity standard was then obtained by a boron poisoning technique. The relation to the reactivity of control rod displacement, self-shielding of two control rods, and rise of the solution level over the critical level was determined. (auth)

1230 (CVNA-192) MONTHLY OPERATING REPORT [ON CVTR PROJECT], SEPTEMBER 1963. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Contract [AT(30-1)-2289]. 27p.

No operation of the reactor took place this month as work continued on locating and sealing off header cavity leakage. A variety of procedures was used to locate leaks depending on their suspected locations. The majority of possible checks on refueling equipment was completed and dry and wet runs are awaiting opportune periods. (auth)

1231 (DLCS-1010102) REACTOR PLANT CONTAINERS. Core 1, Seed 4. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Mar. 26, 1963. Second issue, July 12, 1963. Third issue, Sept. 25, 1963. Contract [AT(11-1)-292]. 13p.

A procedure for testing the integrity of reactor plant containers for leak tightness is described, along with the equipment used. The container leak rate was determined from an inclined differential water manometer. Following pressurization of the containers to 2 psig, the leak rate was observed to be approximately 0.63 in. of water per

hour. In order to reduce the leak rate to the acceptable value, at 2 psig, of less than 0.05 in. of water per hour, it was necessary to stop a number of leaks located at the air-lock doors. Closing the valves corrected this leak. Leakage from two other valves was stopped by using two in. pipe plugs. Following this, a permissible leak rate was observed at a container pressure of 2 psig. (P.C.H.)

1232 (DLCS-5000863) MONTHLY OPERATING REPORT [ON PWR OPERATIONS], AUGUST 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT (11-1)-292. 44p.

Operation was governed by power requirements, training program, testing, and maintenance. A safety shutdown occurred during the training period when the rod operation selector switch was inadvertently placed in the shutdown position. Reference water conditions were maintained in the RCS and the reactor plant auxiliary systems. Contamination and radiation levels were within specified limits in all but a few areas in the reactor plant. Test results are reported. (N.W.R.)

1233 (DLCS-5000963) MONTHLY OPERATING REPORT [ON PWR OPERATIONS], SEPTEMBER 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT (11-1)-292. 42p.

The station was shut down twice during the month for reactor plant cooldown and heat-up training for operations personnel. A decrease in condenser vacuum necessitated the shutdown of the main unit generator following the return to power operations after the first training period. However, condenser conditions were stabilized and power operations resumed. During the investigation of the condenser problems, tube leakage was detected in the 1B feedwater heater which resulted in isolating the 1B and 1C feedwater heaters for repair of the tube leakage. Subsequently, the heaters were returned to service following completion of repairs. Construction continued on the erection of the decontamination system facility. (auth)

1234 (EUR-464.f) ÉTUDE DE LA ZONE OPTIMALE DES PARAMÈTRES INDÉPENDANTS D'UN RÉACTEUR ORGEL ASSOCIÉ A UNE CENTRALE DE 250 MWeb. ÉLÉMENTS COMBUSTIBLES EN UC GAINÉS SAP TYPE AUTOPORTANT EN GRAPPES DE SEPT CRAYONS. (Study of the Optimum Zone of the Independant Variables of an ORGEL Reactor Connected to a 250-MWeb Power Plant. Fuel Elements Made of UC with SAP Cladding, with Seven Fuel Rods and Individual Pressure Tubes). B. Chambaud, F. Lafontaine, and P. Tauch (European Atomic Energy Community). 1963. 73p.

The optimum zone of the independent variables of an ORGEL reactor connected to a 250-MW power plant was investigated. These independent variables determine the fuel element geometry (7-rod type) as well as the geometry of the reactor core and the operation of the plant. Characteristics of two optimal power plants are given. (auth)

1235 (EUR-466.d) STUDIE DER OPTIMALEN ZONE DER UNABHANGIGEN PARAMETER EINES ORGEL-REAKTORS IN EINEM 250-MWe-KRAFTWERK. SELBSTTRAGENDES BRENNELEMENT AUS UC, SAP-UMHULLUNG MIT 4 BRENNSTOFFSTABEN UND INDIVIDUELLEN DRUCKROHREN. (Study of the Optimum Zone of the Independent Variables of an ORGEL Reactor Connected to a 250-MWeb Power Plant. Self Supporting Fuel Elements Made of UC, with Sap Cladding with Four Fuel Rods and Individual Pressure Tubes). F. LaFontaine and P. Tauch (European Atomic Energy Community). 1963. 39p.

The optimum range of the independent variables of an ORGEL reactor connected to a 250-Mw power plant (4 fuel rods of UC with individual pressure tubes), as well as the geometry of the reactor core and the operation of the plant, is described. (auth)

1236 (GA-4496) HIGH-TEMPERATURE GAS-COOLED REACTOR CRITICAL EXPERIMENT AND ITS APPLICATION. R. G. Bardes, J. R. Brown, M. K. Drake, P. U. Fischer, D. C. Pound, J. B. Sampson, and H. B. Stewart (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 1963. Contract AT(04-3)-314. 47p. (CONF-133-36).

From International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

Two types of critical experiments were conducted in support of the 40-Mw(e) Peach Bottom HTGR nuclear-design program. The first was the test-lattice experiment, where detailed measurements of reaction rates were examined in a lattice having a cold neutron spectrum characteristic of the HTGR. This program provided a method for checking the resonance integral of thorium, the Doppler coefficient of thorium, the detailed flux distribution in the lattice, and control-rod effectiveness within a cell. The second experiment was designed as a gross test of the calculational procedures and data. A small critical experiment having a clean geometry and a composition similar to that of the HTGR was constructed. This assembly had approximately one-sixth the volume of the HTGR core and was surrounded on all sides by a 2-ft graphite reflector. Owing to the small core size and the large reflector area, this experiment provided a severe test of the calculational methods. Experiments with this facility encompassed reactivity-coefficient measurements, neutron-flux distributions, effectiveness of groups of control rods, and a measurement of the overall temperature coefficient. (N.W.R.)

1237 (GAMD-1907) SOME TRANSPORT THEORY AND MONTE CARLO CALCULATIONS ON THE NUCLEAR BEHAVIOR OF THE BORE. A. J. Goodjohn, G. W. Hinman, and G. H. Nickel (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 25, 1960. Contract AT(04-3)-187. 51p.

The validity of simpler analytical techniques in calculating heavily loaded, heterogeneous reactors of the type contemplated for the BORE was examined by a series of multigroup transport and Monte Carlo calculations. The complex space-energy flux variations in the typical reactor cell were investigated by the DSN one-dimensional, multigroup transport code in the thermal neutron energy range (0.002–0.68 ev) and by a Monte Carlo code in the epithermal energy range (0.68–61.4 ev). A reactivity calculation for the complete reactor, core plus reflector, was performed using the DSN code and cross sections derived from the cell calculations. The thermal cell calculation revealed significant variations from simpler one-group calculations. The disadvantage factor for the heterogeneous cell, for example, revealed the effects of neutron moderation by the diluent in the fuel element and of complicated source shape in a group calculation. Both of these effects add complications to any simple treatment. The Monte Carlo calculation of the epithermal range revealed complex energy-space flux variations that are not amenable to any simple analytical technique. (auth)

1238 (GC(VI)/INF/53) NUCLEAR POWER COSTS. (International Atomic Energy Agency, Vienna). Aug. 30, 1962. 13p.

Information on the construction costs for existing nuclear power plants and for those planned or under construction is summarized. Operating costs available are also included. (D.C.W.)

1239 (GEAP-4048) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Eighth Quarterly Progress Report, April–June 1962. J. A. Hodde, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 10, 1962. Contract AT(04-3)-189. 75p.

A frequency analysis was made of the VBWR stability test data. Interpretation of the steady-state noise observed in the stability tests involved consideration of several possible sources of excitation. One of these, a theory of water surface waves, is summarized. Visual and destructive examinations were made of selected fuel rods. Fretting corrosion of the Zircaloy-clad fuel rods against stainless steel spacers was observed. Evidence that UO_2 thermal conductivity increases with time was obtained. Hot gas isotatic pressed fuel rods failed after 316 Mwd/T irradiation and 5 months storage under water. Shakedown operation of a 7-rod test section for measuring burnout heat flux was conducted. A comparison of measured and calculated isotopic composition for uranium and plutonium isotopes after 400 Mwd/T irradiation indicated that the calculations underestimate capture in U^{238} and overestimate capture in Pu^{239}. Flux wire irradiations provided axial and radial flux profiles and the ratio of thermal to fast flux as a function of axial position. (M.C.G.)

1240 (GEAP-4305) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR STARTUP PROCEDURES. Fifth Quarterly Progress Report, April 1–June 30, 1963. E. Garelis and P. Meyer (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 15, 1963. Contract AT(04-3)-189. 15p.

A technique is being developed to use pulsed neutron generators to measure the startup procedures and shutdown margin of large, thermal power reactors. The theory of pulsed neutron source measurements is being investigated for use in reflected assemblies. The performance of two fission counters is discussed. (N.W.R.)

1241 (GEAP-4332) NUCLEAR SUPERHEAT PROJECT. Sixteenth Quarterly Report, May–July 1963. W. L. Flock (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Aug. 15, 1963. Contract AT(04-3)-189. 71p.

The ESH-1.1 fuel assembly was replaced in VBWR for continued irradiation. Design and development work is proceeding on EVESR prototype elements to be installed in ESH-3. Material specifications for nuclear quality Inconel 600, Incoloy 800, and 300 series stainless steel were formulated and issued. The fabrication techniques and properties for Incoloy are described. Testing of cladding materials in the CL-1 and -4 loops is evaluated. The E-SADE condenser was replaced and loop operation resumed with ESH-1.1. Installation and checkout of the Mixed Spectrum Critical Assembly (MSCA) is approximately 80% complete. A test program is established for loading the core to the design power split which will extend over four months. Physics calculations of an MSSR core with and without a small amount of moderator indicate the degraded spectrum obtained with 1.6 vol % polyethylene results in an increase in Doppler coefficient by a factor of two. The large power spike at the outer edge of the fast core can be reduced by increasing the fast buffer thickness with little change in the power split. (N.W.R.)

1242 (GEAP-4389) DEVELOPMENT PROGRAM FOR THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 4. T. Sorlie (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 14p. (EURAEC-839)

The encapsulated reactor pressure vessel material specimens were installed in predetermined location in the SENN plant. Effort was directed towards the physics computer functions. The core physics calculations described will analyze the following: power distribution, xenon transients, integrated fuel exposure, and integrated control blade exposure. (auth)

1243 (HPR-30) HBWR QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1963. (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). July 1963. 161p.

Operation was devoted to experiments to measure the reactor transfer function both at low and high power. Operation was made at the maximum design power of 20 Mw. A model was developed for calculating the control worth and the real and adjoint neutron flux distributions in a control rod poisoned reactor, where the control rods are placed in a ring around the core center. The core is radially reflected and the control rods are treated in a heterogeneous fashion. The second charge dynamics model was extended and improved. The model was run on an analog computer in an attempt to predict the reactor transient behavior observed when HBWR was subjected to tertiary steam load and reactivity perturbations. The gamma heat generated in Zircaloy and cadmium strips of the sinusoidal reactivity oscillator and the resulting temperatures were estimated as a function of the means of cooling and indicated the necessity of a forced air cooling of the oscillator assembly. The reactivity step generator fabricated for possible use in the dynamics studies was functionally tested. The design of the third instrumented fuel assembly was completed and fabrication is in process. The assumptions and calculations in the design of the gamma thermometers for measuring local power under steady state conditions and for indicating the axial flux shape are given. Out-of-pile and in-pile experiments were made with the second instrumented fuel assembly. The results of the first instrumented fuel assembly are corrected. Tests were made on the electrically heated boiling test loop motor-generator equipment to determine the normal operating characteristics and maximum capacities of the equipment. (N.W.R.)

1244 (IDO-19313) ADDITIONAL ANALYSIS OF THE SL-1 EXCURSION. Final Report of Progress, July–October 1962. (General Electric Co. Flight Propulsion Lab. Dept., Idaho Falls, Idaho). Nov. 21, 1962. Contract AT(10-1)-1095. 177p. (TM-62-11-707)

Work was carried out to obtain significant data on reactor excursions, in particular the SL-1 excursion, to extend the analysis of reactor transient behavior so as to obtain an improved understanding of the thermal and mechanical processes that take place during and following a reactor excursion, and to obtain chemical, metallurgical, and nuclear data relative to the pre-accident performance of the SL-1. Laboratory investigations were made of samples of the SL-1 power plant. Results are given and their significance discussed. An attempt was

made to construct a mathematical model of reactor excursions, based partly on fundamental thermodynamic and nuclear considerations, and using some empirical results. This model was applied to SPERT and BORAX excursions with some success. Recommendations concerning reactor design and operation, which have arisen from the SL-1 accident and its analysis, are summarized. Results are presented in tables and graphs. (M.C.G.)

1245 (LADC-5936) OPERATIONAL EXPERIENCE AND DEVELOPMENTAL ACTIVITIES IN LASL SODIUM SYSTEMS. Robert A. Clark (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 37p. (CONF-258-1)

From Sodium Components Development Program Information Meeting, Palo Alto, Calif., Aug. 1963.

The LAMPRE sodium coolant system is described, and system operating characteristics and malfunctions observed during the past 4 and ½ years are reported. Included is the description of the liquid level probe, sodium analysis, nitrogen diffusion problem, and the fission gas monitor. The program for evaluating hot-trap material for oxygen gettering is described and preliminary results for Zr, Ta–10% W, and Nb are presented. A description of a sodium pressure transducer using the LVDT principle and having a ±1% accuracy at 400°C is presented. Physical properties of Types 304, 316, 316L, and 17-4 PH stainless steel after exposure for 5000 and 10,000 hours at 625°C in zirconium hot-trapped sodium are reported. (auth)

1246 (MND-MD-2544) PM RESEARCH AND DEVELOPMENT PROGRAM. PM CORE 3 PARAMETRIC STUDY. R. Lightner, C. George, and W. Brittain (Martin-Marietta Corp. Aerospace Div., Baltimore). Oct. 1963. Contract AT(30-1)-2706. 98p.

Results are presented of a parametric study of the third generation PM core. The core is intended as a replacement loading for the PM-1 and PM-3A reactors, as well as the initial core for subsequent PM plants. Hence, the envelope and control rod pickup locations are identical to PM Cores 1 and 2. Core 3 is composed of: tubular stainless steel cermet fuel elements; B_4C-Zircaloy 2 pellet-in-tube lumped burnable poison elements; and $Eu_2O_3 \cdot TiO_2$-stainless steel pellet-in-tube finger-type control elements. In the nuclear parametric study, lifetime and maximum reactivity were determined for the following parameter variations:

Fuel Matrix thickness (mils)	60 to 90
Wt % UO_2 in matrix	35 to 45
B-10 per lumped poison element (gm)	1.6 to 2.4
Fuel element-to-poison element ratio	2.2 to 3.6

For the maximum reactivity range of interest, 0.04 to 0.06 ΔK/K, core lifetimes from 69.5 to 128.5 Mw-yr were calculated. Supporting nuclear calculations were also performed concerning the worth of the finger control system as a function of the number of fingers and europium loading per finger; use of cadmium as an alternate burnable poison was investigated. Thermal-hydraulic studies were also performed as part of the parametric study. Maximum fuel temperature and fraction of burnout heat flux were determined for optimum (from a nuclear lifetime viewpoint) cores containing fuel elements of various thicknesses and fuel loadings. Operating conditions for a typical uprated PM plant were selected, viz., 30-Mw(t) power, 3750-gpm flow rate, 500°F average coolant temperature and 1200-psia pressure. Maximum fuel temperatures ranged from 750° to 932°F. Maximum fractions of burnout heat flux were excessive, ranging up to 0.87. Performance of a single optimized core was investigated parametrically in operating conditions. This study indicated that Core 3 performance will ultimately be limited by maximum fuel temperature, assuming flexibility in choice of coolant conditions. Results of the study indicate that a Core 3 design is achievable which provides at least 100-Mw-yr lifetime with reasonable burnable poison loading and number and loading of finger control elements. A maximum power capability of at least 30 Mw(t) is also achievable. Considerable benefit may be derived by axial zoning of the poison concentration in the burnable poison elements. (auth)

1247 (NP-13212) VERHALTEN DER BRENNSTOFF-ELEMENTE UNTER BETRIEBSBEDINGUNGEN. (Behavior of the Fuel Elements [of the Lucens Reactor] under Operating Conditions). Report No. 3220-01. W. Helbling (Therm-Atom A. G., Winterthur, Switzerland). Nov. 2, 1961. 54p.

The properties of various U–Mg alloys for use in fuel elements are discussed. The force that must be exerted on the fuel elements for the Lucens Reactor to prevent the boundary rods from bowing following unsymmetrical volume increase and temperature distributions was calculated. The bowing must be prevented by guiding the rods laterally. The creep deformation of the fins under the influence of applied lateral force was assessed. (M.C.G.)

1248 (NP-13213) DIMENSIONNEMENT DE LA SURFACE DE REFROIDISSEMENT DES ÉLÉMENTS DE COMBUSTIBLE. (Design of the Cooling Surface of the Fuel Elements [for the Lucens Reactor]). Report No. 3210-06. G. Ciszewski and W. Helbling (Therm-Atom A. G., Winterthur, Switzerland). July 11, 1962. 42p.

The optimum number and shape of longitudinal fins for the cooling surface of fuel elements for the Lucens Reactor was determined by a simplified optimization. Polyzonal fins were rejected, although superior according to calculations, mainly because of mechanical problems and lack of heat transfer experiments. (auth)

1249 (NP-13214) DYNAMISCHES VERHALTEN DES REAKTORS NACH STORUNGEN. (Dynamic Behavior of Reactors after Perturbations). Report No. 2330-02. J. Gilbert, R. Naegelin, P. Palanikumar, and F. Schwarzentruber (Therm-Atom A. G., Winterthur, Switzerland). July 26, 1962. 100p.

Methods and results of a series of analog computer studies of blower failures, coolant blockage, reactivity accidents, etc., in a reactor are presented. These calculations were applied to the Lucens Reactor. (M.C.G.)

1250 (NP-13215) DIMENSIONNEMENT DU COEUR DU REACTEUR DE LUCENS. (About the Core Dimensions of the Lucens Reactor). Report No. 3230-03. J.-P. Schneeberger (Therm-Atom A. G., Winterthur, Switzerland). Sept. 12, 1961. 52p.

A survey of parametric studies about fuel elements and core for the Lucens Reactor is presented. The fuel element was optimized by taking the power density as parameter and comparing the neutron characteristics of varied fuel-element configurations. For selected fuel elements two-group core calculations were performed. The results, which also take into account previous work on flux flattening in core arrangements with two different lattice spacings, are given in tables. (auth)

1251 (NP-13216) UNTERSUCHUNG UBER REAKTOREN MIT VARIABLEM GITTERABSTAND. (Studies on Reactors with Different Lattice Spacings). Report No.

3230.01. J.-P. Schneeberger (Ther-Atom A. G., Winterthur, Switzerland). May 5, 1961. 22p.

Investigations were made on gas-cooled heavy-water-moderated reactors with two different active zones relative to flux flattening and costs. The effect of an interior reflector was studied. Results were applied to the Lucens Reactor. (auth)

1252 (NP-13217) PILOTAGE DES BARRES DE COMMANDE. (Specifications for the Control System [of the Lucens Reactor]). Report No. 6230-02. A. Roch (Therm-Atom A. G., Winterthur, Switzerland). Aug. 1, 1963. 11p.

The different modes of controlling the absorber rods of the Lucens Reactor are described. The main requirements concerning the regulating system and the safety system are defined. (auth)

1253 (NP-13218) ZUR FRAGE DER WAHL DER HULLENWERKSTOFFE FUR DIE URAN-BRENNSTOFF-ELEMENTE DES REAKTORS LUCENS. (On the Choice of Canning Materials for the Uranium Fuel Elements of the Lucens Reactors). Report No. 3320-03. E. Bodmer (Therm-Atom A. G., Winterthur, Switzerland). July 3, 1962. 27p.

Some properties of canning alloys for uranium fuel elements of the Lucens Reactor are discussed. In the temperature range from 250 to 450°C Magnox A.12 possessed a higher creep strength than Mg–Zr. The latter alloy, however, showed better corrosion properties in storage well water. The Magzan 2 (ZM1) had promising properties. (auth)

1254 (NP-13219) ACCIDENTS DE DEMARRAGE. (Start-up Accident Studies [for the Lucens Reactor]. Report No. 6210-01. Y. Fishman (Therm-Atom A. G., Winterthur, Switzerland). Oct. 22, 1961. 21p.

An analog study was made of the response of the D_2O-moderated gas-cooled Lucens Reactor to a ramp of reactivity over 10 power decades, using the method of decade commutation. In the thermal power range, temperature feedback is introduced. (auth)

1255 (NP-13220) ZUR FRAGE DER ERHOHTEN SPRODBRUCHANFALLIGKEIT DES DRUCKROHR-WERKSTOFFES ZIRCALOY-2 DURCH KORROSIONS-WASSERSTOFFAUFNAHME AUS FEUCHTEM CO_2. (On the Increased Brittle Fracture Tendency of the Pressure Tube Zircaloy-2 Material Caused by the Corrosion and Hydrogen Absorption from Moist Carbon Dioxide). Report No. 3320-04. E. Bodmer (Therm-Atom A. G., Winterthur, Switzerland). Aug. 30, 1962. 7p.

The calculated hydrogen pick-up by the Lucens Reactor pressure tube Zircaloy-2 material is discussed. The increase in hydrogen content is so small (about 1 ppm in 20 yr) as not to be able to give rise to any increase in tendency to brittle fracture. (auth)

1256 (NP-13221) PROGRAMM FUR DIE BERECHNUNG VIELSCHICHTIGER REAKTOREN. (Program for Computations of Multi-Zone Reactors). Report No. 3230-02. B. Gloor (Therm-Atom A. G., Winterthur, Switzerland). Feb. 7, 1962. 40p.

Starting from diffusion theory and the Spinrad formalism, a one-dimensional code was developed to compute the macroscopic dimensions of reactors. The code is based on reports of Saclay. (auth)

1257 (NP-13222) PUISSANCE THERMIQUE TOTALE DÉGAGÉE DANS LES ÉLEMENTS COMBUSTIBLES APRÈS UN ARRÊT D'URGENCE. (Total Thermal Power Produced in the Fuel Elements [of the Lucens Reactor] after an Emergency Shut-Down). Report No. 2330-03. J. Gilbert (Therm-Atom A. G., Winterthur, Switzerland). Feb. 12, 1962. 11p.

The calculation of the total thermal power produced in fuel elements after an emergency shutdown takes into account the contribution of the fission power as well as the power due to the fission products, based on recently published data. The results, which are valid for the Lucens Reactor, are used in the lay-out of the primary coolant system. (auth)

1258 (NP-13223) GEFAHR VON SCHNELLEN CHEMISCHEN REAKTIONEN DER SPALTSTOFF-ELEMENTE IN DER ANLAGE LUCENS. (Risk of Fast Chemical Reactions of the Lucens Fuel Elements). Report No. 2330-06. R. Naegelin (Therm-Atom A. G., Winterthur, Switzerland). Oct. 4, 1962. 30p.

A literature survey of the reactions of uranium, magnesium, and graphite with carbon dioxide, air, and water is presented. Forty references are given. (M.C.G.)

1259 (WAPD-PWR-TE-157) REACTOR COOLANT RADIONUCLIDE BASE LEVELS, PWR CORE 1, SEED 4. W. Lechnick (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1963. Contract AT(11-1)-Gen-14. 10p.

Base level fission product activity levels for Core 1, Seed 4 operations were below or equal to base levels observed for Seed 2 and Seed 3 operations. Assuming conservatively that the blanket and seed contributed equally to fission product levels at start of Seed 4 life, the U-nat contamination level in the new seed was on the order of 4 ppm or less. Absolute contamination level of the new seed could not be determined because background activity from the blanket fuel would have experienced a gradual but undetermined buildup of Pu^{239} from U^{238} during operation. The decrease in specific activity of Cu^{64}, $Mn^{54,56}$, $Sr^{89,91,92}$ and $Ba^{139,140}$ is attributed at least in part to the relatively high primary coolant pH existing at the time the samples were drawn. Alpha activity in the primary coolant was identified as Po^{210}. (auth)

1260 (WCAP-2361) 1000-MWE SUPERCRITICAL PRESSURE NUCLEAR REACTOR PLANT STUDY. Sixth Quarterly Progress Report, April 1, 1963–June 30, 1963. G. B. Brown and H. B. Kellogg, eds. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Aug. 1963. Contract AT(30-1)-2948. 161p.

Operation of the high-temperature supercritical pressure heat transfer loop and design and costs of the 1000-Mw(e) supercritical pressure once-through tube reactor (SCOTT-R) were further analyzed. Basic heat transfer data were obtained from the loop in the pressure and heat flux ranges of 2400 to 4000 psia and 0 to 0.9×10^6 Btu/hr ft^2, respectively. For these tests, cylindrical tubes of 0.1- and 0.2-in. ID and lengths 2 to 9 ft were used. The data are being reduced and analyzed to obtain heat transfer correlations in sub- and supercritical pressure regions. The design of an annular test section to provide single and two side heating was completed. The design of the test section for the stress corrosion experiments was resumed. Design and evaluation of the 1000-Mw(e) SCOTT-R plant was 99% completed. (auth)

1261 UNIT IN THE MOL POWER STATION. E. Maryssael and J. Lys. Electricite, No. 111, 23-38(July 1963). (In French)

A technical description of the new power station at Mol (Belgium) is presented. The 125 Mw 127 kg/cm^2

540/540°C reheat set, boiler, (which is p.f. and oil fired) auxiliaries, control room etc. are described. (TCO)

1262 HUNTERSTON—FIRST REACTOR CRITICAL. Nucl. Eng., 8: 394-6(Nov. 1963).

The modifications that were made to the original plan for the reactor are discussed, and the original approach to criticality is described. The refuelling equipment, which was extensively modifed, is also described along with the refuelling operation. (D.C.W.)

1263 ECONOMICS OF PLUTONIUM UTILIZATION IN NUCLEAR POWER PROGRAMMES. SYSTEM ACCOUNTING MORE EFFECTIVE THAN ISOLATED STATION ASSESSMENT. C. E. Iliffe (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng., 8: 399-403(Nov 1963).

An economic criterion is presented for accounting for plutonium in the economic assessment of a nuclear power station in isolation. Applications of the criterion are reviewed, and numerical results are included. Extending the assessment to a wider proportion of the generating system resolves the accounting problem. (D.C.W.)

1264 THE APPROXIMATE DETERMINATION OF THE FLOW AND TEMPERATURE FIELD IN PEBBLE-BED GAS-COOLED REACTOR. Bohdan Krajewski and Jan Szczurek (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 8: 249-57(1963). (In Polish)

A numerical example of the determination of the flow and temperature field in the gas flowing through the packed beds is given. The method is applied to the case when the thermal conductivity of the gas is neglected and the total pressure is assumed to be constant in the considered region. Bearing in mind that the considered differential equation corresponds to a variational problem, the Ritz's method is used for obtaining the numerical solution. The method describes the flow and temperature distribution in the gas in a more complete way and gives results more accurate than any other existing method. (auth)

1265 SOME BASIC SAFETY CONSIDERATIONS IN THE DEVELOPMENT OF POWER-PRODUCING REACTORS. F. R. Farmer. p.1-14 of "Nuclear Safety. Vol. 5, No. 1."

The range of the more serious accidents possible in large power-producing reactors and the effect the limitations imposed by safety considerations have had on the development of various reactor systems are discussed. Reactor safety provisions are reviewed with the objective of seeking simplification of complex systems. Reactivity, loss-of-flow, and depressurization accidents are described for gas-cooled, fast, and water-cooled and -moderated reactors. The role of containment is outlined. (M.C.G.)

1266 DIGITAL COMPUTER CONTROL OF POWER REACTORS. C. W. Ricker. p.62-3 of "Nuclear Safety. Vol. 5, No. 1."

The use of digital computers in nuclear power plants for improving operating efficiencies and control and for greater safety is discussed. Examples of the use of computers for control of nuclear reactors are described. Economic aspects of their use are considered. (M.C.G.)

1267 ACTION ON REACTOR PROJECTS BY LICENSING AND REGULATING BODIES. J. R. Buchanan. p.127-35 of "Nuclear Safety. Vol. 5, No. 1."

The license-application records of various power reactors are reported in tables. Actions and activities relative to Big Rock Point Reactor, Bodega Bay Reactor, BONUS Reactor, CVTR, Dresden Reactor, Elk River Reactor, Enrico Fermi Atomic Power Station, Humboldt Bay Reactor, Indian Point Reactor, La Crosse Reactor, Nuclear Fuel Services Reprocessing Plant, N.S. Savannah, Peach Bottom Reactor, Piqua Nuclear Power Facility, Saxton Reactor, Vallecitos Boiling-Water Reactor, Vallecitos Experimental Superheat Reactor, and Yankee Reactor are described. (M.C.G.)

1268 THE DESIGN OF GAS-COOLED GRAPHITE-MODERATED REACTORS. D. R. Poulter, ed. New York, Oxford University Press, 1963. 702p. $13.45.

The Calder Hall type of reactor and the Advanced Gas-Cooled Reactor are considered. The topics presented include design concepts, steady-state reactor physics, reactor kinetics and control philosophy, plant safety, reactor materials, fuel elements, graphite structure, cooling system, fuel handling, shielding, power utilization, instrumentation, control, power supplies, and civil and structural engineering. Appendices are included on lattice calculations and stability theory. Separate abstracts are prepared for each of the 20 papers. (C.E.S.)

For abstracts of individual chapters see: 417, 557, 558, 627, 1198, 1199, 1200, 1201, 1202, 1203, 1214, 1215, 1221, 1222, 1269, 1270, 1271, 1272, 1273, and 1274.

1269 THE DESIGN CONCEPT. A. Hitchcock. p.1-33 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Design criteria based on cost data, experimental data on reactor physics and heat transfer, and the physical limits set on certain parameters by properties of materials and constructional techniques are discussed. The pattern of the initial design process, design compromises, modifications, optimization calculations, and commissioning are also considered. (C.E.S.)

1270 STEADY-STATE REACTOR PHYSICS. B. Cutts. p.34-70 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

The relative probabilities of occurrence of neutron events such as scattering, absorption, and fission are considered, and the way in which these probabilities are influenced by the material temperatures and irradiation history is discussed. Formulas for the multiplication constant of an infinite reactor, the thermal utilization factor, the resonance integral, and neutron yield are presented. The procedure in design calculations, the neutron cycle in a thermal reactor and its relation to empirical calculations, macroscopic flux distributions, effects of reactor operation on reactivity, control calculations, fuel cycles, and future developments in reactor physics calculations are also considered. (C.E.S.)

1271 REACTOR KINETICS AND CONTROL PHILOSOPHY. F. W. Fenning. p.71-95 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Causes of transient conditions in reactors and reactor response to these conditions are considered to determine control system design and time response of safety devices. Methods for calculating neutron mean lifetime, periods and abundances of delayed neutrons from fission, heat capacity and conductivity of fuel and moderator, heat-transfer characteristics, temperature coefficients of reactivity of each reactor component, coolant circuit time, and kinetic behavior of heat exchangers are outlined. Stability of the power distribution and requirements of the control and safety system are also described. (C.E.S.)

1272 PLANT SAFETY. B. E. Eltham and J. H. Bowen. p.96-124 of "The Design of Gas-Cooled Graphite-

Moderated Reactors." New York, Oxford University Press, 1963.

The maximum permissible dose of ionizing radiations and radioactivity associated with the gas-cooled graphite-moderated reactor are discussed. The fuel activity and induced activity in the fuel elements, the moderator, reflector, coolant, and the steel pressure circuit are considered. Hazards analysis and design features to alleviate the effect of hazards are also discussed. (C.E.S.)

1273 REACTOR POWER UTILIZATION. N. Bradley and F. Kay. p.468-92 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Methods for economically and efficiently converting the heat energy available in the reactor coolant to electrical power are considered. Steam cycles, economic factors, heat-exchanger design, and optimization of the power utilization system are discussed. (C.E.S.)

1274 FUTURE DEVELOPMENT. J. D. Thorn. p.617-29 of "The Design of Gas-Cooled Graphite-Moderated Reactors." New York, Oxford University Press, 1963.

Principles likely to lead to the achievement of cheaper power are considered in an attempt to determine the changes necessary in future reactor development. (C.E.S.)

1275 LARGE GRAPHITE COLUMNS IN THE CORE OF THE EXPERIMENTAL GAS-COOLED REACTOR (EGCR). James V. Neely (Allis-Chalmers Mfg. Co., Washington, D. C.). p.354-64 of "Proceedings of the Fifth Conference on Carbon. Vol. 1." New York, Pergamon Press, 1962.

The graphite core of the Experimental Gas-Cooled Reactor consists of 120 columns, each 20 ft long with a nominal 16 in. square cross section. Non-uniform neutron irradiation damage to the graphite columns creates internal stresses and causes bowing or distortion of the graphite columns. Bowing cannot be tolerated. Mechanical restraint of the bowing causes additional flexural stresses in the columns. There are limited basic design data available on mechanical properties, creep behavior, and irradiation damage for the conditions of operation of the EGCR. In the design analysis, a simplified model is used together with extrapolations of existing data. Calculations using elastic theory indicate that the stress produced by the irradiation damage may exceed the ultimate strength of the graphite in a relatively short time. It is expected that creep will occur and relieve the stresses and thereby extend the time to failure by a significant amount. However, there are limitations on the amount of strain which the graphite can accept without failing. Because of the uncertainties involved in the graphite stress analysis, the core of the EGCR is designed to remain operable even if some of the columns crack. Some suggestions are made for investigations that would provide essential design formation on the behavior of large graphite bodies under conditions simulating reactor conditions. (auth)

1276 ESTABLISHING AND MAINTAINING A HIGH PURITY INERT ATMOSPHERE IN EBR-II FUEL CYCLE FACILITY ARGON CELL. J. H. Schraidt (Argonne National Lab., Ill.); L. F. Coleman, W. F. Holcomb, M. Levenson, and J. O. Ludlow. Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 181-90(1963).

The Experimental Fuel Cycle Facility, built as part of the Second Experimental Breeder Reactor system, contains a shielded cell in which a high-purity, inert atmosphere is required for fuel reprocessing and refabricating. Impurity levels of less than 100 ppm oxygen plus water and 5% nitrogen are desired. Argon was selected as the inert gas. The volume of the cell and associated gas-handling equipment is about 66,000 cubic feet. The cell is maintained at a pressure negative to the surrounding area and the atmosphere is purified by removing the oxygen and moisture present. The cell was filled with nitrogen to determine the inleakage rate and to test cell pressure control and purification equipment. After the leak rate was determined to be about 0.004 ft^3/min., operating at a cell pressure of 4 inches of water negative to the atmosphere, the cell was then maintained at an oxygen concentration less than 20 ppm and a moisture concentration of less than 10 ppm for periods up to a week. (auth)

Process Heat Reactors

1277 (TID-19574) PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report, August 1–October 31, 1961. N. H. Coates, R. F. Stewart, W. T. Abel, C. C. Shale, J. P. McGee, and L. L. Hirst (Bureau of Mines. Morgantown Coal Research Center, W. Va.). 25p.

Heat transfer tests with the ½-inch cooler for the 250-psig helium recycle loop were completed. Helium film coefficients ranged from 62 to 188 Btu/hr-ft^2-°F as Reynolds number was varied between 4,400 and 17,500. The operating characteristics of the helium recycle compressor are being determined at 100, 150, 200, and 250 psig and at helium temperatures of 100, 400, 700, and 1,000°F. Helium flow is being varied from 2,000 to 4,000 scfh up to the maximum flow that will not overload the compressor motor. The compressor operates at a constant speed of 18,600 rpm. Design work was completed on a coal gasifier for the ISR system, and construction of the unit is progressing. Additional induction heating was provided so that gas-solids suspensions can be heated in the helium-graphite suspension loop to at least 500°F., and a positive displacement meter was installed to measure the flow of suspensions. A torsion-bar dynamometer that measures shaft deflections was used to determine compressor motor output at various speeds and input voltages. Tests were then made to determine the compressor power required to transfer heat with helium. The design and procurement of equipment are continuing for a pilot-scale system with a 10-hp centrifugal compressor to operate at 1,200°F. Suspensions of 105 to 250 μ graphite in nitrogen at 50 psig were recycled through the laboratory-scale system to determine the rate of particle degradation. Most degradation occurred within 2 hours, after which the maximum and minimum size of particles was only 15 and 1 μ. To determine the thermal stability of methane in stainless-steel tubes, mixtures of methane and steam were heated to 1,200 to 1,800°F in the helium-heated coal gasifier. Results could not be evaluated owing to difficulties in analyzing mixtures of hydrocarbon gases. Attempts to gasify low-temperature bituminous coal tar in the same gasifier were unsuccessful. At steam-tar weight ratios of 6 and 10, the preheaters plugged with coke. Electrical characteristics were previously determined for a precipitator with stainless steel or platinum electrodes operating on clean and dust-laden air at temperatures to 1,500°F and pressures to 80 psig. These results could not be duplicated. Tests with the platinum electrodes were repeated. At 1,500°F the results were erratic, indicating that current leaked through the insulator. At all temperatures and pressures of the tests, positive polarity permitted application of higher voltages. (auth)

1278 INDUSTRIAL HEAT-PRODUCING REACTORS. K. Schwarz (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 451-65(Sept. 1963). (In German)

The use of nuclear energy for industrial heat is discussed. Topics covered include: requirements of industrial heat, assumptions for the use of reactors in the production of industrial heat, economic uses of primary energy, problems of safety, advantages and disadvantages of process-heat reactors, research in the USA, and economic aspects of thermal reactors. Some process-heat reactors are described. (M.C.G.)

Production Reactors

1279 (CONF-255-6) THE SRP PRODUCTION REACTOR CONTAINMENT PROGRAM. J. A. List (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Oct. 1, 1963. Contract AT(07-2)-1. 7p.

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

A program is under way at the Savannah River Plant to increase the containment facilities as much as practical in the existing production reactor buildings. The major features of the system are outlined, and the air cleaning portion of the installation is discussed in detail. (auth)

1280 (HW-SA-3213) HANFORD EXPERIENCE WITH REACTOR CONFINEMENT. W. V. Thompson and H. C. Copeland (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 23, 1963. Contract [AT(45-1)-1350]. 15p. (CONF-255-4)

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

The Hanford reactor confinement system for preventing the release of fission products to the atmosphere, is described. The following parts of the system are described in some detail and its testing and operational experience discussed: ventillation system, filter facility, instrumentation, and fog spray system. (D.L.C.)

Propulsion and Space

Refer also to abstract 659.

1281 (ASD-TDR-63-833) BEARING ANALYSIS FOR THE SPUR TURBOGENERATOR. A. Bosco and E. Wheeler (Garrett Corp. AiResearch Mfg. Div. of Arizona). Sept. 1963. Contract AF33(657)-8954. 76p.

The results of the analysis of journal bearing configuration for the SPUR turbogenerator are presented. For this analysis, a computer program was used that solves the basic hydrodynamic equations, including consideration of fluid inertia forces in both the turbulent and laminar regimes. Solutions were obtained for a number of bearing configurations, using this program, with potassium as the lubricant. The computer run with laminar analysis agreed with existing solutions, thereby providing a check of the computer program. Several journal bearing mounting arrangements were considered, and a design was selected for initial testing. (auth)

1282 (CENRD/HP/62/2) S1C PROTOTYPE REACTOR FACILITY. Environmental Monitoring Report, January–June 1962. Volume III, Number 2. (Combustion Engineering, Inc. Naval Reactors Div., Windsor, Conn.). July 1962. Contract AT(30-3)-519. 9p.

Approximately 45.96 mC of beta radioactivity was released during the period January to June 1962 in liquid waste effluent and dilution water. The average concentration released was 8.7×10^{-6} μC/cc. All liquid waste was released at less than $^1/_{10}$ the permissible concentrations for continuous exposure as specified by the National Committee on Radiation Protection and Measurements for the radionuclides present. The Farmington River was sampled monthly at various locations upstream, and downstream of the Industrial Waste Outlet and at the outlet. The average of the river results indicate values of 3.1×10^{-8}, 1.3×10^{-8}, and 2.3×10^{-8} μC/cc beta at the upstream, outlet and downstream locations, respectively. Radioactive fallout is collected on a weekly basis at six locations around the site (on-site) and analyzed for gross beta radioactivity. Radioactive fallout is also collected at eleven off-site locations in neighboring towns and analyzed for gross beta radioactivity. Comparison of the weekly averages of all on-site sampling stations indicated 19.71 mC/mi^2/sample and 20.64 mC/mi^2/sample for all off-site sampling stations. Airborne waste effluent monitored at the point of release for beta radioactivity indicated an average concentration of 4.0×10^{-11} μC/cc, for the period January to June 1962. This compares with the recommendations of the National Committee on Radiation Protection Standards, 1×10^{-10} μC/cc, for the radionuclides involved. Air samples taken downwind of the point of release during the period indicates an average of 7.1×10^{-12} μC/cc beta. Measurements of radioactivity in the Farmington River, the Industrial waste effluent from the plant, air and fallout, in the S1C Prototype vicinity, during the period January to June 1962 indicated no significant contribution of radioactivity from the S1C Prototype to the environment. Furthermore it can be stated that radioactivity discharged to the environment under controlled conditions from the S1C Prototype, during waste disposal operations, were in full compliance with the recommendations of the National Committee on Radiation Protection and the radiation protection standards established by the Federal Radiation Council. (auth)

1283 (GEMP-245) 710 REACTOR PROGRAM TEST PLANS AND FACILITY REQUIREMENTS. (General Electric Co. Advanced Technology Services, Cincinnati). Oct. 15, 1963. Contract AT(40-1)-2847. 42p.

Conceptual studies were completed that define the philosophy, plans, radiological hazards, and facility requirements for development testing of the 710 reactor system. Conceptual test sites and facility arrangement options were considered. Detailed test plans, estimated facility costs, and construction schedules are included. (P.C.H.)

1284 (LA-2284) NUCLEAR PROPULSION TEST REACTOR KIWI-A NEUTRONIC STUDIES. J. D. Orndoff and J. C. Hoogterp (Los Alamos Scientific Lab., N. Mex.). Sept. 1958. Contract W-7405-eng-36. 53p.

Critical conditions were obtained for a series of uranium–graphite fueled assemblies in the C/Oy range 150 to 500 with thick graphite reflectors and Be or D_2O islands. Perturbations were studied in order to find the effect on reactivity of geometrical changes and engineering features. Information from these studies was used to develop a mockup of an optimum reactor geometry for the first rocket reactor test device, Kiwi-A. Studies on a zero power mockup (Zepo-A) helped establish its design details. A cold critical check was made of the Kiwi-A reactor. (auth)

1285 (NAA-SR-Memo-8268) STRESS ANALYSIS—EXPANSION COMPENSATOR SUPPORT STRUCTURE. J. R. Boulanger (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 1, 1963. Contract AT(11-1)-Gen-8. 18p.

The structure that supports the bellows assembly in the expansion compensator was analyzed. The structure was shown analytically to take the forces to which it will be subjected. The two critical conditions considered were: during operation when the compensator has a K–Na volume of 60 $in.^3$ and a temperature of 800°F. During the operating condition the stresses are sufficiently low to prevent any appreciable relaxation due to creep. (auth)

1286 (ORNL-3476) AN EVALUATION OF THE SUBSTITUTION OF ZIRCALOY FOR STAINLESS STEEL IN N.S. SAVANNAH FUEL-ELEMENT CONTAINERS. Summary Report. T. D. Anderson, E. E. Gross, H. C. McCurdy, L. D. Schaffer, L. R. Shobe, and C. L. Whitmarsh (Oak Ridge National Lab., Tenn.). Nov. 6, 1963. Contract W-7405-eng-26. 79p.

The possibility of reducing fuel-cycle costs for the N.S. SAVANNAH by replacing the stainless steel fuel-element containers in the permanent reactor core structure by similar containers of a zirconium alloy was investigated. These containers, although not integral parts of the fuel-bearing components, are located within the active core and divide the core into 32 separate channels into which the fuel elements are placed. Areas of investigation included reactor physics, fuel-cycle economics, materials compatibility, structural design, and reactor hazards. A summary of the method of analysis and results is given for each area of investigation. Calculations indicated that the substitution of Zircaloy containers would increase core reactivity about 6% Δk and control-rod worth about 4% Δk. Fuel-cycle costs would be reduced about 26%. Zircaloy-4 appears to be compatible with the reactor system, except for some uncertainty with respect to fretting corrosion, which can be resolved only by tests. The substitution of cold-worked Zircaloy for stainless steel in the container assembly would necessitate only minor design modifications. Although this evaluation is strictly applicable only to the N.S. SAVANNAH reactor, the results demonstrate the feasibility and advantages of using zirconium alloys for in-core capital-cost components. (auth)

1287 (TID-19563) HEAT TRANSFER AND HYDRAULIC STUDIES FOR SNAP-4 FUEL ELEMENT GEOMETRIES. Topical Report No. 2. Bruce Matzner (Columbia Univ., New York, Engineering Research Labs.). Sept. 1963. Contract AT(30-3)-187. 32p.

Forty-two instrumented burnout points are reported for the second 12-rod test section which had 0.440-in. diameter rods with a minimum spacing of 0.022 in. between rods. Each rod was wrapped with a 0.022-in. wire. The rods were arranged in a 3 × 4 array to form a 60° parallelogram. A contoured housing maintained the minimum spacing between the outer rods and the housing wall. The tests were performed with vertical upflow at 1200 psia. The ranges of variables studied were: mass velocities from 0.5 to 4.1×10^6 $lb/hr\text{-}ft^2$, exit steam qualities between 2 and 52%, and instrumented burnout heat fluxes as high as 1.28×10^6 $Btu/hr\text{-}ft^2$. The burnout results showed a strong direct mass velocity effect at exit qualities below 10%. Above 10%, an inverse mass velocity effect was seen to develop particularly at high mass velocities. All the burnouts were observed to take place on outer rods facing the unheated housing walls. Hence, these results provide an estimate of the burnout performance of only the outer rods since the interior rod surfaces have higher burnout heat flux limits in this geometry. A qualitative analysis is made for predicting the burnout location in a rod bundle. Two phase pressure drop measurements were made to show that the flow was inherently stable in the area of interest for the Snap 4 reactor. Rod surface temperatures were measured and heat transfer coefficients were calculated. (auth)

1288 OPERATING EXPERIENCE WITH NUCLEAR PROPULSION: START-UP AND INITIAL OPERATION OF N. S. SAVANNAH. J. W. Landis. J. Joint Panel Nuclear Marine Propulsion, 7: 1-15(Oct. 1963).

The principal design data for the nuclear power plant are listed; and the significant aspects of the pre-critical testing, fuel loading, initial criticality, zero power tests, power operation, and sea trial tests are reviewed. Operation of the power plant was entirely successful with only a few minor corrections made; the predicted characteristics were confirmed. Only two unintentional scrams of the power plant, both insignificant, occurred on the first two voyages. Information indicating significant design improvements was obtained. (D.C.W.)

1289 DESIGN STUDY FOR MARINE PROPULSION MACHINERY INCORPORATING A BOILING WATER REACTOR, AS TENDERED IN 1960. A. W. Davis. J. Joint Panel Nuclear Marine Propulsion, 7: 17-54(Oct. 1963).

A design submitted for a 20,000-shp nuclear propulsion system suitable for a 65,000-ton tanks is described. The philosophy behind the design and characteristics of the reactor system is given, and the development and potential of the system is considered. (D.C.W.)

1290 REMOTE HANDLING OPERATION FOR DEVELOPMENT TESTING OF NUCLEAR ROCKETS. Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 175-9(1963).

Hot cell work in the nuclear rock program is discussed. Topics covered include: nuclear rocket program; R-MAD remote-handling facilities; nuclear rocket engine maintenance, assembly, and disassembly facility; E-MAD wall-mounted handling system; and other special equipment in E-MAD. (M.C.G.)

Research and Test Reactors

1291 (AECL-1840) THE BEHAVIOUR OF URANIUM AND ALUMINUM IN THE NRU HEAVY WATER SYSTEM. H. K. Rae (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oct. 1963. 20p. (CONF-243-5)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

The NRU reactor has operated for five years with hundred-gram quantities of uranium in the core releasing fission products to the water. This situation, while causing inconvenience and complicating maintenance work, has not created any serious operating problems. The studies of uranium and aluminum transport throughout the heavy water system that are summarized indicate that the controlling factors are the concentrations of ionic uranium and aluminum. These ionic concentrations are much lower than the total concentrations of these elements in the water, and they cannot be measured directly. The important processes affecting the gross transport of uranium or aluminum are dissolution of the source material to form the ionic species followed by sorption or crystallization on oxide surfaces throughout the system, both corrosion product films and oxide particles. It is believed that the same processes are important in high-temperature systems and can control corrosion product release, crud disposition on fuel sheaths, and the transport of activity. Thus, the studies in NRU may help to interpret the behavior of power reactor systems. (auth)

1292 (AECL-1842) SOME PROBLEMS ASSOCIATED WITH OPERATING THE CHALK RIVER REACTORS. J. H. Collins and C. A. Herriot (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). Oct. 1963. 10p. (CONF-243-8)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A brief discussion is given of operating problems encountered in NRU and NRX, particularly the control and safety systems of NRX and the tracing and repair of a leaking calandria tube in NRX. (D.L.C.)

1293 (AECL-1843) THE REFUELLING OF NRX WITH URANIUM OXIDE. F. W. Barclay (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oct. 1963. 6p. (CONF-243-7)

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

An outline is presented of the problems encountered in the replacement of the natural U metal rods in NRX with UO_2 rods. These problems included possible damage from rapid pressure rise, reactivity oscillations from prototype annular rods, and design and cooling of the booster rods. The installation of the UO_2 rods, which commenced in Dec. 1959, is described. The maximum flux now is 1.2×10^{14} n/cm^2/sec, an increase of 40% over its previous value. The performance of the new fuel rods to date is described briefly. (D.L.C.)

1294 (ANL-6745) THE BIOLOGICAL IRRADIATION FACILITY ("JANUS" REACTOR) DESIGN MANUAL. W. H. McCorkle, A. W. Pierce, and D. C. Thompson (Argonne National Lab., Ill.). June 1963. Contract W-31-109-eng-38. 168p.

The design and characteristics of the Janus Reactor Facility for medical and biological research are described in detail. Pertinent information is given about the nuclear and reactor radiation characteristics of the facility. Information is presented on the design and operation of reactor components, auxiliary equipment, instruments, and associated equipment. Maintenance and operating instructions are included for the facility. Cost breakdown is outlined. (N.W.R.)

1295 (APDA-153) STUDY OF REQUIREMENTS AND SUITABILITY OF AVAILABLE REACTORS FOR FAST FUEL TESTS. T. A. Doyle, J. G. Duffy, W. H. Jens, W. E. McHugh, E. M. Page, and H. S. Warberg (Atomic Power Development Associates, Inc., Detroit). Feb. 23, 1963. Contract AT(11-1)-865. 50p.

The requirements for radiation space for fast reactor fuel testing and the capability of existing test and power reactors to meet these requirements were studied. Particular attention was given to the possible modification of the EOCR to a sodium cooled fast reactor fuel testing facility. The future requirements for fast fuel testing as compiled, based on the estimates given by potential fast fuel experimenters, are extensive and cannot be completely met with existing test or fast reactors. Only a part of the total program can be accomplished by using liquid metal loops in test reactors and these tests would be very costly. Most of the proof testing of subassemblies can be accomplished in either the EBR-II or the Fermi fast reactor. A fast test reactor with considerable testing space in the form of open and closed loops will be required for the fast reactor program. A total of eight closed loops and eight open loops of from 3 to 6 in. in diameter would be required, in addition to ten 1.5-in. holes and several 5-in. holes for capsule experiments for the total program. Part of these requirements can be considered met by the subassembly positions in EBR-II and the Fermi reactor. The closed loops must be designed to accommodate fuel tests taken to failure, and to operate at a very high fast neutron flux. These large closed loops are the principal deficiency in the existing fast reactors. In the ETR and ATR, it is theoretically possible to install a loop or a capsule with a boron filter to obtain sufficiently high heat generation rates without serious flux depressions to obtain a worthwhile test. In these cases the total test reactor power that is required is very high and would result in very high operating costs and low reactor utilization. The fast region in the proposed two-region SRE with the PEP thermal core appears to be mechanically satisfactory and feasible from a material compatibility standpoint. A fast converter in this reactor design is somewhat limited, since the total heat-generation in the fast sample is about one-third of the value in the ETR for the same acceptable or superior flux depression. By substituting enriched for depleted uranium in the mixed oxide test sample, the minimum acceptable heat generation could be achieved. A liquid metal fast loop in the EOCR is easier to accommodate mechanically and physically than in other test reactors that are not cooled by liquid metal, because of the better compatibility of sodium and organic. Using a boron filter, the heat generation in the fast test sample is about one-third of the value in the ETR and is, therefore, not particularly attractive. It does not appear to be practical to directly convert the EOCR to an FTR because of the need for containment and the major neutron shielding changes required. However, it does appear to be feasible and attractive to consider building a small FTR immediately adjacent to the EOCR, using the EOCR reactor vessel as a heat exchanger vessel between sodium and organic and the existing organic as a secondary coolant system. Although no detailed physics analyses were made, it appears that the MTR, the General Electric Test Reactor (GETR), and the Westinghouse Test Reactor (WTR) are not suitable for filtered fast loop experiments. In these reactors the power density is considerably below that required for a satisfactory heat generation in the fast fuel specimen. In addition, no provisions were made in the MTR to install loops in the core. It may be possible to increase the power density or harden the spectrum, however, to make these suitable for this work. (auth)

1296 (HW-63401) PRTR PRIMARY PUMP FLYWHEEL ANALYSIS. J. Muraoka, R. G. Clark, and E. E. Utz (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 3, 1960. Contract AT(45-1)-1350. 13p.

The ability of a prototype PRTR primary pump equipped with a flywheel (1185 lb-ft^2 moment of inertia) to maintain adequate coolant flow, in a total electric power failure, until natural convection flow became sufficient was investigated. Experiments showed that the flywheel decay times varied from one to three minutes; an analytical study showed that mechanical friction in the pump seals can produce the variation. In all instances, the flywheel maintained adequate flow until after convective flow would have started. (D.C.W.)

1297 (HW-SA-3185) HAPO GRAPHITE IRRADIATION CAPSULES. J. W. Helm (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 18, 1963. Contract AT(45-1)-1350. 31p. (CONF-227-8)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Maryland, Oct. 1963.

A summary is presented of the broad field of graphite irradiation capsules. The various capsule designs are considered; they include temperature-controlled and temperature-monitored capsules. The components and materials of the capsules are described. Finally, methods are given for carrying out heat transfer calculations in capsule design and neutron spectra calculations for correlation of radiation data from different reactors. (D.L.C.)

1298 (HW-SA-3227) HANFORD IRRADIATION CAPSULES FOR IN-REACTOR CREEP MEASUREMENTS AND URANIUM SWELLING STUDIES. J. A. Williams and R. D. Leggett (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 1, 1963]. Contract AT(45-1)-1350. 12p. (CONF-227-9)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Maryland, Oct. 1963.

A description is given of a capsule which measures creep of structural materials during irradiation at constant temperature and uniaxial stress. The capsule operates at 200 to 400°C at a He pressure of 500 psig, and a uniaxial tensile creep stress of 40,000 psi may be applied to the specimen. A description is also given of a capsule for irradiating U at constant temperature for swelling studies. (D.L.C.)

1299 (IDO-16920) SPERT PROJECT QUARTERLY TECHNICAL REPORT, APRIL–JUNE 1963. F. Schroeder, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 20, 1963. Contract AT(10-1)-205. 52p.

The low-enrichment, rod-type UO_2 core previously tested in Spert I was reloaded in the facility in preparation for a test program which will culminate in a planned destructive test. Static measurements of the control rod reactivity worths and the isothermal temperature coefficient of reactivity verified data obtained in the previous test series. A series of experiments is being planned to obtain additional information on the origin of the large pressure pulse observed in the destructive test previously performed with a highly enriched plate-type core. Hardware was constructed for irradiation of several fuel plates in the reflector region of the Spert I oxide core during the forthcoming test series. Modifications to the Spert II facility were completed and an operational core loading was achieved in preparation for a series of excursion tests investigating the effects of initial system pressure, temperature, and coolant flow rate on the kinetic behavior of a close-packed D_2O-moderated core configuration. The previously reported series of power excursion tests in Spert IV with an 18-ft hydrostatic head was extended to include tests with periods as short as 7.0 msec. Extrapolation of the data indicated that fuel plate surface temperatures would be expected to reach the melting temperature for excursions with periods shorter than about 6 msec. Tests were performed to investigate the effect on the kinetic behavior of the Spert IV core of various initial coolant flow velocities from zero to 12 ft/sec. Addition of flow within this range had no appreciable effect on the magnitude of the initial power burst for tests with periods shorter than about 50 msec. The relative magnitude and the frequency of the power oscillations observed following the initial burst were found to decrease as the flow rate was decreased. A detailed inspection of the Spert IV core following completion of this test series revealed that a hole had melted in one of the fuel plates in the central fuel assembly of the core. It was postulated that mechanical deformation of the plate during the initial power burst of a 10-msec-period test with 5000 gpm forced coolant flow caused blocking of the coolant channel resulting in steam blanketing and burnout of the plate. Further tests are in progress to obtain additional information on the conditions which resulted in the melting of the plate. The Power Burst Facility (PBF) was designed to generate power bursts with periods as short as 1 msec, and to produce energy releases large enough to destroy fuel assemblies placed in capsules or flow loops mounted in an internal flux trap in the center of the reactor core, without damage to the core itself. Additional work is in progress on optimization of the core design and on plans for a fuel testing program to evaluate the performance of the fuel design proposed for the initial PBF core. In an analysis of errors generated in the numerical evaluation of unilateral Fourier transforms derived from a continuous record of analog data, error criteria were developed, which are somewhat less restrictive with respect to requirements on the data than are those usually obtained by assuming that only discrete data points are known. Analysis of data from high-power pile-oscillator tests previously performed in Spert I continued with the evaluation of the transfer function at a mean power level of 600 kw. An improved method was developed for smoothing and normalizing transfer function data in order to permit extraction of the feedback transfer function in the frequency domain above 0.1 cps. (auth)

1300 (JEN-118-DF/I-35) SISTEMA DE CONTROL DEL REACTOR JEN-1. (JEN-1 Reactor Control System). M. Fajardo Cantillo, C. Martin Nuno, and J. L. Monleon Andreu (Spain. Junta de Energia Nuclear, Madrid). 1963. 51p.

The JEN-1 3Mw power swimming pool reactor electrical control circuits are described. Start-up, power generation in the core, and shutdown are controlled by the reactor control system. This control system guarantees in each moment the safety conditions during reactor operation. Each circuit was represented by a scheme, complemented with a description of its function, components, and operation theory. Components described include: scram circuit; fission counter control circuit; servo control circuit; control circuit of safety sheets; control circuits of primary, secondary, and clean-up pump motors and tower fan motor; primary valve motor circuit; center cubicle alarm circuit; and process alarm circuit. (auth)

1301 (MIT-NE-23) PROCESS SYSTEM REQUIREMENTS OF THE MIT REACTOR AT FIVE MEGAWATTS (thesis). William Robert Devoto (Massachusetts Inst. of Tech., Cambridge). Aug. 1962. 182p.

Operating ranges of the major process systems of the MIT Reactor are projected to a power level of five megawatts. Reasonable limitations are set on the maximum fuel plate temperature and the bulk temperature of the D_2O primary coolant. A lower limit is placed on the flow rate of the primary coolant. Consistent with these limitations, the fuel loading per element is limited according to the amount of excess reactivity in the core. The flow rate of the H_2O secondary coolant necessary to remove the heat load from the primary system under the above limitations is investigated. The efficiency of the cooling tower which cools the secondary coolant is evaluated and projected to five megawatts. The shield coolant system is examined under five megawatt conditions. Recommendations are made as to additional equipment necessary to provide ade-

quate, compatible process systems for operation of the MITR at a power level of five megawatts. (auth)

1302 (ORNL-TM-692) ORR OPERATIONS FOR PERIOD APRIL 1962 TO APRIL 1963. W. R. Casto and W. H. Tabor (Oak Ridge National Lab., Tenn.). Nov. 18, 1963. Contract W-7405-eng-26. 97p.

The second full year of operation of the ORNL Research Reactor at 30 Mw was without incident. The average operating time was 79.2% which is lower than usual because of an exceptionally long shutdown at the end of cycle No. 44 for the installation of GCR-Loop No. 2. Additions made to the control system include: automatic insertion of the No. 6 shim rod if a setback signal is received while operating in manual, a Sola power regulator for smoother instrument power regulation, low-level scrams when operating without coolant flow, and dual count-rate channels. The radiation and contamination safety were improved by a pressurizable off-gas system and modifications of the decontamination scrubber to give greater reliability. Operating instruments and equipment were improved for increasing usefulness of the research facility. (N.W.R.)

1303 (RT/FI(63)-20) ENERGY SPECTRUM OF FAST NEUTRONS FROM THE RC-1 REACTOR (TRIGA MARK II). H. G. de Carvalho, M. C. Ramorino (Italy. Comitato Nazionale per l'Energia Nucleare. Centro di Studi Nucleari, Casaccia); A. Manfredini (Italy. Istituto Nazionale di Fisica Nucleare, Rome); S. M. G. de Barros, and A. G. da Silva (Rio de Janeiro. Centro Brasileiro de Pesquisas Fisicas). Apr. 1963. 22p.

Measurements, by means of nuclear emulsions, of the energy spectrum of the fast neutrons from the central beam hole of the RC-1 Reactor (TRIGA Mark II) are described. The results and the fits obtained for them are presented. (auth)

1304 (RT/FI(63)-30) MISURA DELLA FUNZIONE DI TRASFERIMENTO DEL REATTORE ISPRA-1. (Measurement of Transfer Function of Ispra-1 Reactor). U. Farinelli and C. Ponti (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio Fisica e Calcolo Reattori, Ispra). May 1963. 10p.

The low power transfer function of the Ispra-1 reactor was measured by means of a rotating-type pile oscillator. The results are compared with calculations, taking into account the effective fractions of delayed neutrons and photoneutrons. A good agreement is found with the calculated value of the prompt lifetime (about 6×10^{-4} sec). (auth)

1305 (RT/ING(63)3) MISURE DI REATTIVITA MEDIANTE CONTROLLO AUTOMATICO DEL FLUSSO NEUTRONICO. (Measurement of Reactivity by Means of Automatic Neutron Monitoring). G. Ambrosini and T. Bozzoni (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratorio Ingegneria e Servomeccanismi Reattori, Ispra). Jan. 1963. 47p.

A facility is described to measure absorption and fission cross section of small samples which are used in connection with the Ispra 2 swimming pool reactor. The measuring is done by compensating with a rotating rod and the reactivity controlled by the samples introduced into the reactor by means of a special device. Several factors affecting the measurement accuracy, such as reactor noise, temperature drift etc., are considered. System dynamics are studied and the design outlined to optimize a figure of merit that in this case is the measurement time, which effects the accuracy. By means of a continuous calibration method, it looks possible to reach an accuracy of about $^1/_{100}$ of p.c.m. with samples of 10 p.c.m. An analogical study is described of the process where several assumptions of the theoretical design are considered and which confirms the previous results. (auth)

1306 (TID-19421) ADVANCED TEST REACTOR CRITICAL EXPERIMENTS. Final Report. A. L. MacKinney, G. W. Fiscus, R. H. Lewis, and J. W. Poston (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). Aug. 1963. For Ebasco Services, Inc., New York. Contract AT(10-1)-1075. 455p. (ATRCE-111)

The Advanced Test Reactor Critical Experiment was operated in support of the physics and engineering design of the ATR reactor core. Features of the reactor are the nine flux traps resulting from the serpentine arrangement of 40 fuel elements creating a clover-leaf pattern, the 16 rotating control cylinders each having a hafnium plate attached over a 120-degree arc, which enables the cosine shape of the axial flux to be unperturbed throughout core lifetime, and the asymmetric power generation among the core lobes accomplished by unbalancing the control cylinders and neck shim rods. The total excess reactivity of the core containing no burnable poison was $21.10, with $17.00 available in control elements. A boron-coated Mylar tape simulated in the burnable poison would be incorporated in the fuel matrix of a production fuel element. The temperature coefficient of the fuel element region was about −2.5 ¢/C; of the nine flux traps about +1.26 ¢/C; and of the neck filler region and the beryllium reflector about +1.63 ¢/C. The net temperature coefficient for the entire core was about +0.39 ¢/C. The over-all temperature coefficient was a function of control element positions. Values for the ratio l^*/β were obtained from pulsed neutron measurements at delayed critical conditions, spectral noise analysis, and pile oscillator techniques. Although the values from the first two methods were in good agreement, the pile oscillator values were substantially higher. The value of l^*/β generally increased as the efficiency of the reflector became higher, since the preferential delayed neutron effectiveness was reduced. Neutron flux measurements verified a truly symmetrical power generation in the core when all 16 control cylinders were in a balanced condition and flux trap conditions were identical. Vertical flux measurements verified the expected cosine shape of the axial power generation with a peak-to-average ratio of 1.44. Absolute neutron flux values were extrapolated to the reference design power of 250 MW. (auth)

1307 PHYSICS CALCULATIONS FOR THE PHILIPPINE OPEN-POOL REACTOR PRR-I. A. CROSS SECTIONS AND INFINITE MULTIPLICATION FACTOR. Jose O. Juliano (Philippine Atomic Energy Commission, Manila). Philippine J. Sci., 91: 381-92(Dec. 1962).

The Philippine Open-Pool Reactor PRR-1 is a MTR type reactor. It is fueled with 20% enriched U metal, is light-water-moderated, and is graphite- and water-reflected. The core and fuel element dimensions and physical parameters are outlined, and the neutronic data (thermal-neutron group constants, fast-neutron group constants, thermal utilization factor, resonance escape probability, diffusion constants, infinite multiplication factor, criticality conditions, etc.) are presented. (T.F.H.)

1308 FUEL UNLOADING MACHINE OF THE DRAGON REACTOR: AN INTERESTING [SWISS] ACHIEVEMENT IN THE NUCLEAR FIELD. A. Robert. Schweiz. Tech. Z., 60: 301-7(Apr. 25, 1963). (In French)

A description of the fuel element unloading machine for

the EURATOM "Dragon" reactor at Winfrith Heath is presented. (TCO)

1309 CONTINUOUSLY MEASURING pH AND CONDUCTIVITY OF DISTILLED WATER IN THE PRIMARY CIRCUIT OF THE CZECHOSLOVAK NUCLEAR REACTOR. František Voženilek (Nuclear Research Inst., Czechoslovak Academy of Sciences, Prague). Tech. Dig. (Prague), 5: No. 1, 41-5; 49(Jan. 1963).

Experience with the operation of the Czechoslovak experimental reactor (VVR-S cooled and moderated by distilled water) made it desirable to extend the original measuring equipment by units checking important characteristics of the distilled water used for cooling the active zone. The usual procedure of samples drawn and analyzed periodically proved unaccommodating and a continuous method for measuring pH and conductivity was worked out. Difficulties encountered and experience gained before the final solution was adopted are described, and some results of operational measurements of both characteristics are reported. (P.C.H.)

1310 TWO YEARS OF OPERATING AN ALPHA-BETA-GAMMA LABORATORY AT SACLAY. A. Valentin (Commissariat a l'Energie Atomique, Paris). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 211-21(1963).

Within the frame work of the "Rapsodie" fast reactor program, prototype plutonium fuel elements are irradiated in the El-3 reactor and then examined in an α-β-γ laboratory at Saclay. This laboratory is essentially intended for metallurgical research and is composed of five cells in which α-sealed dry boxes are associated with magnetic transmission manipulators. Nitrogen circulating in a closed loop forms the atmosphere of the boxes. This laboratory began operation in April, 1961. Operational incidents were always of a material nature only. (auth)

1311 OPERATING EXPERIENCE OF THE OAK RIDGE RESEARCH REACTOR THROUGH 1962. W. H. Tabor. p.116-23 of "Nuclear Safety. Vol. 5, No. 1."

Operation of the Oak Ridge Research Reactor and associated experiment facilities is discussed. Topics covered include: routine operation, reactor components, mechanical controls, water system, corrosion in the system, reactor kinetics, experiments, and personnel radiation exposure. (M.C.G.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 9 and 1282.

1312 (HW-77830) THE EFFECT OF HEAT ON THE VAPORIZATION AND ELUTION OF Sr^{85} AND Cs^{137} ADSORBED ON ZEOLITES. K. C. Knoll (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 26, 1960. Contract AT(45-1)-1350. 31p.

Seven inorganic ion exchangers containing adsorbed Sr^{85} and Cs^{137} were treated in a flowing air stream at temperatures from 130 to 1000°C. The amount of the nuclide found in the gas stream and the fraction of the nuclide eluted from the exchangers were determined. The amount of nuclide vaporized appeared to be independent of the temperature. The average amount of the radionuclide found in the off gas was 0.04% of that adsorbed by the zeolite. At least 90% of the cesium and strontium could be eluted from the exchangers that had been heated at 700°C. Elution was more difficult after heating at 1000°C. (auth)

1313 (NLCO-894) INCINERATION OF WASTE-CONTAMINATED OIL. K. E. Brandner, R. L. Bipes, and L. Williams (National Lead Co. of Ohio, Cincinnati). Sept. 18, 1963. Contract AT(30-1)-1156. 7p. (CONF-255-7)

From 8th Air Cleaning Seminar Oak Ridge, Tenn., Oct. 1963.

Of the various disposal methods investigated for organic liquid wastes contaminated with uranium, incineration proved to be the most successful. An oil burner is now operating on site capable of disposing of 400 to 700 fifty-five gallon drums of mineral oils and emulsions monthly. Uranium recovery from the process is virtually complete, and air contamination is held to acceptable levels. (P.C.H.)

1314 RECENT INVESTIGATIONS INTO TREATMENT OF RADIOACTIVE EFFLUENT. J. H. Clarke and T. D. Wright (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Effluent Water Treat. J., 3: 276-9(May 1963).

The treatment of radioactive effluent has been studied intensively at Harwell, and the most suitable single stage chemical treatment consists of adding 50 mg/l Ca^{2+}, 80 mg/l PO_4^{3-}, and 40 mg/l Fe^{2+} at a pH value of 11.5. This is for an effluent containing a wide range of radioactive isotopes with no excessive concentration of any one of them. The treatment removes approximately 90% of the total β-γ emitters, the principle isotope not effectively removed being Cs^{137}. It is usual, where high decontamination is required, to remove the Cs^{137} by a final ion exchange stage. The ferrocyanides of Zn, Ni, Fe, and Cu, however, have been used in chemical processes for the extraction of Cs from concentrated atomic wastes. In this work the aim has been the recovery of Cs free from other fission products and precipitation has been under acidic conditions. This particular use of ferrocyanide for Cs precipitation has been applied in the treatment of radioactive effluent where Cs concentrations are far less than in the concentrated atomic waste. Its application, however, has been limited to neutral or low pH conditions which are not suitable for the removal of other radioactive species. This disadvantage has been overcome in the past by following a ferrocyanide precipitation with a phosphate or other treatments at a high pH value to remove the residual active ions. It was considered to be advantageous if the ferrocyanide and phosphate precipitation could be combined into a single stage treatment without losing the benefits of either. The development of this scheme and further increase in efficiency which can be obtained by incorporating ion exchange on vermiculite when necessary are discussed. (auth)

1315 EMBEDDING HIGHLY RADIOACTIVE WASTES IN CONCRETE. E. Lazzarini. Ind. Ital. Cemento, 33: 45-52(Jan. 1963). (In Italian)

Fission product leaching from different mortar types was studied in normal water and brine in relation in the immersion time and curing period. Attempts were made to establish the diffusion rate of fission products through layers of cement mortars. The fission product absorption by cement mortars was also investigated. (OTS)

1316 HOT CELL OPERATING EXPERIENCE IN THE CALCINATION OF LIQUID WASTES. R. T. Allemann, R. L. Moore, F. P. Roberts, and U. L. Upson (General Electric Co., Richland, Wash.). Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 139-60(1963).

Pilot plant studies of the calcination of high-level radioactive liquid wastes are in progress at Hanford Laboratories. This work is part of a world-wide effort to fix radioactive wastes in stable solid media, both to minimize storage costs by reducing volume and containment requirements, and to provide a safer form for the storage of such wastes, and for the storage and shipment of mixed or separated fission products. The process operations of pumping, spray drying, calcination, melting, condensation, gas purification, and gas and liquid sampling, as well as calorimetry and gamma analysis, are performed within a 7 × 15-ft cell, behind four-foot-thick walls, by remote manipulation. Electrical resistive and inductive heating within the cell totals nearly 50 kilowatts. The nominal throughput of 1 gallon per hour of concentrated waste (typically about 1M in salts and 2.5M nitric acid) corresponds to the waste from about $\frac{1}{3}$ ton of irradiated uranium per 24-hour day. Some of the engineering and operational problems encountered, and some of the experience gained in one year of operation are described. (auth)

GENERAL AND MISCELLANEOUS

1317 (NP-13210) REPORT ON THE WORK OF THE INSTITUTE OF NUCLEAR SCIENCES. Annual Report No. 5, March 1962–February 1963. (New Zealand. Inst. of Nuclear Sciences, Lower Hutt). May 1963. 113p.

Research and development progress being made on equipment and methods of radiation chemistry, geochemistry, nuclear physics, and accelerator physics are reported. Information is presented on the industrial applications of radioisotopes, carbon-14 and tritium age measurements, carbon-13 variations in nature, well logging, tracer techniques, mass spectrometry, fallout monitoring, counting equipment and engineering physics, underground water analysis, and isotope measurements. Other information is presented on administrative matters, publications, research projects, and equipment. (N.W.R.)

1318 ATOMIC ENERGY IN THE SOVIET UNION. Trip Report of the U. S. Atomic Energy Delegation, May 1963. (Atomic Energy Commission, Washington, D. C.). 89p.

The itinerary of the 11-day visit of the U. S. Atomic Energy Delegation in the Soviet Union is outlined. The delegation visited 14 sites, including 10 large scientific installations, and a detailed account is given of the facilities and research programs at each site. A brief comparison is made of the nuclear research program of the U.S. and Soviet Union, and the research program in the Soviet Union is evaluated. (C.E.S.)

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This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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ø		oe
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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number in that volume. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Published literature (journal article or book) is identifiable by the absence of a report number.

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466.d	18-1235	Dep.(mc)
EURAEC–		
70	18-581	Dep.(mc); $1.60(fs), $0.80(mf) OTS
152	18-397	Dep.(mc); $8.10(fs), $2.81(mf) OTS
183	18-611	Dep.(mc); $1.10(fs), $0.80(mf) OTS
205	18-398	Dep.(mc); $4.60(fs), $1.46(mf) OTS
215	18-448	Dep.(mc); $4.60(fs), $1.67(mf) OTS
224	18-551	Dep.(mc); $1.10(fs), $0.80(mf) OTS
265	18-552	Dep.(mc); $1.10(fs), $0.80(mf) OTS
282	18-582	Dep.(mc); $4.60(fs), $1.64(mf) OTS
287	18-489	Dep.(mc); $1.10(fs), $0.80(mf) OTS
290	18-605	See NCSC-2663-7
324	18-583	Dep.(mc); $1 60(fs), $0.80(mf) OTS
356	18-606	See NCSC-2663-8
371	18-649	Dep.(mc); $2.60(fs), $1.01(mf) OTS
390	18-650	Dep.(mc); $1.10(fs), $0.80(mf) OTS
420	18-684	Dep.(mc); $4.60(fs), $1.43(mf) OTS
440	18-378	Dep.(mc); $2.60(fs), $0.95(mf) OTS
504	18-1175	Dep.(mc); $2.60(fs), $0.89(mf) OTS
647	18-553	Dep.(mc); $1.60(fs), $0.80(mf) OTS
736	18-577	Dep.(mc); $5.60(fs), $1.97(mf) OTS
737	18-379	Dep.(mc); $4.60(fs), $1.55(mf) OTS
760	18-643	See BMI-1638
834	18-545	See GEAP-4368
839	18-1242	See GEAP-4389
841	18-596	See ATL-A-139
842	18-1226	See ACNP-63029
843	18-1186	See BMI-X-10062
845	18-542	See BMI-X-10061
846	18-410	See SWRI-1296-6-5
847	18-654	See GEAP-3771-10
FZK–	**(Non-AEC)**	
147	18-651	$9.60(ph), $3.68(mf) OTS
163	18-652	$8.60(fs), $3.11(mf) OTS
9-187	18-657	See NARF-63-8T
GA–	**(Misc.)**	
4282	18-653	Dep.(mc); $1.10(fs), $0.80(mf) OTS
4496	18-1236	Dep.(mc); $4.60(fs), $1.61(mf) OTS
4500	18-198	Dep.(mc); $2.60(fs), $1.07(mf) OTS
GAMD–	**(Misc.)**	
1907	18-1237	Dep.(mc); $5.60(fs), $1.73(mf) OTS
3033	18-977	Dep.(mc); $1.10(fs), $0.80(mf) OTS
GC(VI)/INF–	**(International Atomic Energy Agency)**	
53	18-1238	Dep.(mc)
GEAP–	**(Misc.)**	
3771-10	18-654	Dep.(mc); $7.60(fs), $2.39(mf) OTS
4048	18-1239	Dep.(mc); $7.60(fs), $2.45(mf) OTS
4300	18-1176	Dep.(mc); $8.10(fs), $2.75(mf) OTS
4305	18-1240	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4332	18-1241	Dep.(mc); $7.60(fs), $2.33(mf) OTS
4368	18-545	Dep.(mc); $4.60(fs), $1.46(mf) OTS
4389	18-1242	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEMP–		
245	18-1283	Dep.(mc); $4.60(fs), $1.46(mf) OTS
GNEC–		
299	18-1188	Dep.(mc); $6.60(fs), $2.12(mf) OTS
HASL–		
108	18-490	Dep.; $1.00(OTS)
139	18-431	Dep.; $0.75(OTS)
HPR–	**(Norwegian)**	

Report No.	Abstract No.	Availability
30	18-1243	Dep.(mc)
HW-		
63401	18-1296	Dep.(mc); $1.60(fs), $0.80(mf) OTS
66289	18-423	Dep.(mc); $1.60(fs), $0.80(mf) OTS
67197	18-432	Dep.(mc); $1.60(fs), $0.80(mf) OTS
68716	18-152	Dep.(mc); $1.10(fs), $0.80(mf) OTS
75892	18-199	Dep.(mc); $1.10(fs), $0.80(mf) OTS
77830	18-1312	Dep.(mc); $3.60(fs), $1.13(mf) OTS
77912	18-374	Dep.(mc); $1.60(fs), $0.80(mf) OTS
78706	18-1207	Dep.(mc); $4.60(fs), $1.43(mf) OTS
78734	18-163	Dep.; $0.50(OTS)
78872	18-491	Dep.; $0.50(OTS)
HW-SA-		
2874	18-655	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2983-DRAFT	18-673	Microsampling of Irradiated Materials, Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 223-31(1963)
3029	18-590	Plutonium Fuel-Casting Facility, Proc. Conf. Hot Lab. Equip., 11th, New York, 1963, 169-74(1963)
3088	18-1189	Dep.(mc); $3.60(fs), $1.28(mf) OTS
3141	18-15	Dep.(mc); $1.10(fs), $0.80(fs) OTS; Gmelin, AED-CONF-63-063-10
3173	18-533	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3185	18-1297	Dep.(mc); $3.60(fs), $1.13(mf) OTS
3188	18-124	Dep.(mc); $2.60(fs), $0.98(mf) OTS
3197	18-433	Dep.(mc); $2.60(fs), $1.07(mf) OTS
3213	18-1280	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3227	18-1298	Dep.(mc); $1.60(fs), $0.80(mf) OTS
IA-	**(Non-AEC)**	
846	18-264	Dep.(mc)
IDO-		
16920	18-1299	Dep.; $1.25(OTS)
19313	18-1244	Dep.; $2.75(OTS)
IITRI-	**(Misc.)**	
A6027-6	18-1005	Dep.(mc); $2.60(fs), $1.10(mf) OTS
1209-9	18-518	Dep.(mc); $5.60(fs), $1.94(mf) OTS
IKF-	**(German)**	
8	18-1006	Dep.(mc)
IP-	**(Misc.)**	
488	18-546	Dep.(mc); $10.10(fs), $4.10(mf) OTS
IS-		
595	18-255	Dep.; $2.25(OTS)
618	18-200	Dep.; $1.50(OTS)
JAERI-	**(Japanese)**	
1050	18-1208	
JEN-	**(Spanish)**	
116-DMe/I-11	18-201	Dep.(mc)
118-DF/I-35	18-1300	Dep.(mc)
JINR-	**(Russian)**	
D-1345	18-837	Dep.(mc)
E-1356	18-1007	Dep.(mc)
P-1263	18-838	Dep.(mc)
P-1305	18-839	Dep.(mc)
P-1313	18-1008	Dep.(mc)
P-1317	18-534	Dep.(mc)
P-1318	18-840	Dep.(mc)
P-1331	18-727	Dep.(mc)
P-1334	18-842	Dep.(mc)
P-1336	18-841	Dep.(mc)
P-1337	18-843	Dep.(mc)
P-1338	18-1009	Dep.(mc)
P-1340	18-728	Dep.(mc)
P-1341	18-1010	Dep.(mc)
P-1343	18-729	Dep.(mc)
P-1346	18-535	Dep.(mc)
P-1348	18-844	Dep.(mc)
P-1349	18-730	Dep.(mc)
P-1351	18-1011	Dep.(mc)
P-1357	18-1012	Dep.(mc)
P-1358	18-1013	Dep.(mc)
P-1361	18-1014	Dep.(mc)
P-1367	18-845	Dep.(mc)
P-1368	18-846	Dep.(mc)
P-1370	18-1015	Dep.(mc)
P-1375	18-847	Dep.(mc)
P-1376	18-848	Dep.(mc)
P-1379	18-265	Dep.(mc)
P-1380	18-849	Dep.(mc)
P-1381	18-850	Dep.(mc)
P-1386	18-1016	Dep.(mc)
P-1388	18-1017	Dep.(mc)
P-1389	18-851	Dep.(mc)
P-1391	18-852	Dep.(mc)
P-1404	18-853	Dep.(mc)
JPL-TR-	**(Non-AEC)**	
32-452	18-603	
JPRS-	**(Non-AEC)**	
21472(Del.)	18-49	OTS
21511	18-17	$0.75(OTS)
21628	18-50	$0.50(OTS)
JüL-	**(German)**	
126-MA	18-536	Dep.(mc)
127-PC	18-266	Dep.(mc)
KAPL-		
2285	18-563	Dep.(mc); $2.60(fs), $1.10(mf) OTS
KAPL-M-		
FDF-5	18-978	Dep.(mc); $1.10(fs), $0.80(mf) OTS
JA-6(Rev.VI)	18-1209	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NCF-4	18-1018	Dep.(mc); $6.60(fs), $2.27(mf) OTS
RAR-1	18-979	Dep.(mc); $4.60(fs), $1.67(mf) OTS
SW-3	18-1210	Dep.(mc); $4.60(fs), $1.67(mf) OTS
LA-		
2284	18-1284	Dep.(mc); $5.60(fs), $1.79(mf) OTS
LADC-		
5626	18-604	Dep.(mc); $2.60(fs), $0.98(mf) OTS
5635	18-682	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5782	18-734	Rev. Sci. Instr., 34: 941-2(1963)
5867	18-202	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5889	18-1074	Phys. Rev. Letters, 11: 341-3(1963)
5903	18-980	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5928	18-1075	Phys. Rev. Letters, 11: 343-6(1963)
5930	18-203	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5936	18-1245	Dep.(mc); $3.60(fs), $1.31(mf) OTS
5967	18-434	$1.60(fs), $0.80(mf) OTS
5971	18-435	Dep.(mc); $1.10(fs), $0.80(mf) OTS
LAMS-		
2879	18-436	Dep.; $0.50(OTS)
2898	18-547	Dep.; $1.00(OTS)
2955	18-807	Dep.; $0.75(OTS)
LAS-SR-	**(Misc.)**	
224-4	18-742	See AD-298614

Report No.	Abstract No.	Availability
LNF–	**(Italian)**	
63/62	18-731	Dep.(mc)
MATT–		
186	18-481	J. Opt. Soc. Am., 53: 1259-65(1963)
MDL–	**(Non-AEC)**	
Q1	18-685	Dep.; $4.60(OTS)
MITNE–	**(Misc.)**	
23	18-1301	Dep.(mc); $13.00(fs), $5.66(mf) OTS
ML–	**(Misc.)**	
894	18-1124	OTS
MND-MD–		
2544	18-1246	Dep.(mc); $8.60(fs), $3.14(mf) OTS
MSAR–	**(Misc.)**	
63-142	18-564	Dep.(mc); $3.60(fs), $1.37(mf) OTS
N–	**(Misc.)**	
62-15057	18-651	See FZK-147
63-16439	18-983	See NASA-TM-X-50016
63-16677	18-652	See FZK-163
NAA-SR–		
8388	18-204	Dep.; $0.75(OTS)
8507	18-548	Dep.; $0.50(OTS)
8578	18-578	Dep.; $0.50(OTS)
8833	18-409	Dep.; $0.50(OTS)
NAA-SR-Memo–		
8268	18-1285	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8684	18-981	Dep.(mc); $4.60(fs), $1.49(mf) OTS
8832	18-492	Dep.(mc); $1.10(fs), $0.80(mf) OTS
8857	18-346	Dep.(mc); $1.10(fs), $0.80(mf) OTS
9060	18-982	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NARF–	**(Non-AEC)**	
63-7T	18-656	
63-8T	18-657	$6.60(OTS)
NASA-TM–	**(Non-AEC)**	
X-50016	18-983	$10.50(ph), $4.22(mf) OTS
NASA-TN–	**(Misc.)**	
D-2070	18-529	$1.50(OTS)
D-2226	18-1125	$2.25(OTS)
2096	18-945	$0.50(OTS)
NBS–	**(Misc.)**	
7973	18-1126	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NCSC–	**(Misc.)**	
2663-7	18-605	Dep.(mc); $2.60(fs), $0.86(mf) OTS
2663-8	18-606	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NDL-TR–	**(Non-AEC)**	
28	18-437	$2.60(OTS)
NLCO–		
884	18-164	Dep.(mc); $4.60(fs), $1.58(mf) OTS
889	18-438	Dep.(mc); $1.60(fs), $0.80(mf) OTS
894	18-1313	Dep.(mc); $1.10(fs), $0.80(mf) OTS
895	18-133	Dep.(mc); $1.60(fs), $0.80(mf) OTS
896	18-165	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NOLTR–	**(Non-AEC)**	
62-170	18-607	$10.50(OTS)
62-193	18-537	$6.60(OTS)

Report No.	Abstract No.	Availability
NP–	**(AEC File No. for Non-AEC Reports)**	
13092	18-808	Dep.; $1.00(OTS)
13103	18-399	Dep.(mc)
13109	18-1127	Dep.(mc)
13126	18-439	$22.25(OTS) as AD-420657
13140	18-1019	Dep.(mc)
13192	18-517	
13197	18-515	Dep.(mc)
13198	18-477	Dep.(mc)
13201	18-478	Dep.(mc)
13202	18-267	Dep.(mc)
13210	18-1317	Dep.(mc)
13212	18-1247	Dep.(mc)
13213	18-1248	Dep.(mc)
13214	18-1249	Dep.(mc)
13215	18-1250	Dep.(mc)
13216	18-1251	Dep.(mc)
13217	18-1252	Dep.(mc)
13218	18-1253	Dep.(mc)
13219	18-1254	Dep.(mc)
13220	18-1255	Dep.(mc)
13221	18-1256	Dep.(mc)
13222	18-1257	Dep.(mc)
13223	18-1258	Dep.(mc)
13232	18-166	Dep.(mc)
13234	18-268	Dep.(mc)
13235	18-440	
13240	18-1020	Dep.
13241	18-549	
13243	18-565	
13245	18-375	
13246	18-686	
13247	18-854	
13257	18-816	
13260	18-441	
13262	18-442	
13264	18-1177	
13265	18-817	
13266	18-818	
13267	18-579	
13268	18-1128	
13274	18-687	
13275	18-400	
13276	18-550	
13277	18-819	$3.00(OTS)
13278	18-443	$3.00
13279	18-371	
13280	18-401	
13284	18-566	
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1064	18-214	Dep.(mc); $4.60(fs), $1.46(mf) JCL
1068	18-747	Dep.(mc); $4.60(fs), $1.52(mf) JCL
NRL–	**(Misc.)**	
5970	18-444	
5988	18-608	
6004	18-205	
NYO–		
162-1	18-445	Dep.(mc); $1.60(fs), $0.80(mf) OTS
162-3	18-446	Dep.(mc); $9.10(fs), $3.23(mf) OTS
NYO–		
10575	18-1190	Dep.(mc); $1.60(fs), $0.83(mf) OTS
10695	18-206	Dep.(mc); $3.60(fs), $1.40(mf) OTS
10703	18-44	Dep.(mc); $2.60(fs), $0.89(mf) OTS
ORA–	**(Misc.)**	
03763-13P	18-732	See TID-19561

Report No.	Abstract No.	Availability
ORNL–		
3476	18-1286	Dep.; $2.00(OTS)
3497	18-207	Dep.; $0.50(OTS)
ORNL-TM–		
663	18-1021	Dep.(mc); $1.60(fs), $0.80(mf) OTS
692	18-1302	Dep.(mc); $8.60(fs), $3.11(mf)
701	18-402	Dep.(mc); $8.10(fs), $2.81(mf) OTS
OTS–	**(Misc.)**	
63-31967	18-17	See JPRS-21511
63-41023	18-50	See JPRS-21628
PA-TM–	**(Non-AEC)**	
1029	18-276	
PAN–	**(Polish)**	
266	18-493	Dep.
269	18-688	Dep.
375/XII	18-1191	Dep.
383/II	18-745	Dep.
386/VI	18-855	Dep.
387/VII	18-856	Dep.
389/XIII	18-256	Dep.
390/XIII	18-257	Dep.
392/XIII	18-167	Dep.
393/VIII	18-168	Dep.
394/VIII	18-208	Dep.
399/VI	18-857	
427/II	18-917	Dep.
428/I	18-1022	Dep.
430/I	18-1023	Dep.
431/XVII	18-269	Dep.
432/XVII	18-270	Dep.
436/XVIII	18-858	Dep.
447/XVIII	18-859	Dep.
448/XVIII	18-746	
PATENTS	**(French)**	
75,732	18-1204	See French Patent 1,201,566(Add. 1)
76,538	18-1205	See French Patent 1,201,566(Add. 2)
76,765	18-1206	See French Patent 1,201,566(Add. 3)
1,201,566(Add. 1)	18-1204	
1,201,566(Add. 2)	18-1205	
1,201,566(Add. 3)	18-1206	
PG-Report–	**(British)**	
448	18-169	Dep.; $0.60(BIS); 3s. (HMSO)
PNE–	**(Misc.)**	
304	18-372	Dep.; $0.40(OTS)
PUC–		
1963-114	18-1073	Phys. Rev. Letters, 11: 215-16(1963)
PWA–	**(Non-AEC)**	
2275	18-820	$5.60(OTS)
Q–	**(Misc.)**	
A2392-3-10	18-377	See TID-19549
R–	**(Misc.)**	
63SD77	18-1130	$5.60(OTS)
63SD78	18-1131	$3.60(OTS)
RADC-TDR–	**(Misc.)**	
62-464(Vol. 3)	18-821	$5.60(OTS)
62-524	18-689	$5.60(OTS)
RAI–	**(Misc.)**	
202	18-516	Dep.; $2.50(OTS)
REIC–	**(Misc.)**	
32	18-658	
RHD–	**(Non-AEC)**	
Vol. IV, No. 3	18-461	Radiological Health Data [Monthly Report], Volume IV, Number 3. Public Health Service, Washington, D. C., 1963; $0.50(GPO)
Vol. IV, No. 6	18-462	Radiological Health Data [Monthly Report], Volume IV, Number 6. Public Health Service, Washington, D. C., 1963; $0.50(GPO)
RISÖ–	**(Danish)**	
52	18-1217	Dep.(mc)
RM–	**(Misc.)**	
3538-PR	18-690	$2.60(OTS)
RRL–		
105	18-271	Dep.(mc); $3.60(fs), $1.16(mf) OTS
RT-CHI–	**(Italian)**	
(63)-21	18-170	Dep.(mc)
RT-FI–	**(Italian)**	
(63)-20	18-1303	Dep.(mc)
(63)-22	18-984	Dep.(mc)
(63)-26	18-494	Dep.(mc)
(63)-30	18-1304	Dep.(mc)
RT-GEO–	**(Italian)**	
(63) 32	18-420	Eclogae Geol. Helv., 55: 443-50(1962)
RT-ING–	**(Italian)**	
(63) 3	18-1305	Dep.(mc)
RTD-TDR–	**(Non-AEC)**	
63-3049	18-447	$2.60(OTS)
SAN–		
1006	18-403	Dep.(mc); $5.60(fs), $1.76(mf) OTS
SCDC–		
3300	18-788	See TID-19114
SEL–	**(Non-AEC)**	
62-092	18-1132	
STL–	**(Misc.)**	
6309	18-1178	Dep.(mc); $2.60(fs), $0.89(mf) OTS
SWRI–		
1296-6-5	18-410	Dep.(mc); $8.10(fs), $2.81(mf) OTS
TID–		
3911(Rev. 1)	18-691	Dep.; $1.00(OTS)
4100(1st Rev., Suppl. 18)	18-368	Dep.; Free (DTI Extension)
4100(1st Rev., Suppl. 19)	18-376	Dep.; Free(DTI Extension)
18275	18-692	Dep.; $0.50(OTS)
18628	18-1180	Nucl. Sci. Eng., 17: 310-11(1963)
19004	18-933	J. Math. Phys. (N. Y.), 4: 1415-32(1963)
19114	18-788	Phys. Rev., 132: 1636-7(1963)
19323	18-793	Phys. Rev. Letters, 11: 275-7(1963)
19366	18-519	Dep.(mc); $8.10(fs), $2.90(mf) OTS
19421	18-1306	Dep.(mc); $23.50(fs), $13.85(mf) OTS
19472	18-16	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19484	18-272	Dep.(mc); $2.60(fs), $0.98(mf) OTS
19498	18-8	Dep.(mc); $1.60(fs), $0.80(mf) OTS

Report No.	Abstract No.	Availability
19532	18-693	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19535	18-273	Dep.(mc); $9.10(fs), $3.26(mf) OTS
19545	18-45	$1.60(fs), $0.80(mf) OTS
19548	18-609	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19549	18-377	Dep.(mc); $5.60(fs), $1.91(mf) OTS
19561	18-732	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19563	18-1287	Dep.(mc); $3.60(fs), $1.16(mf) OTS
19565	18-860	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19566	18-861	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19574	18-1277	Dep.(mc); $2.60(fs), $0.95(mf) OTS
19575	18-1184	The Joint Research and Development Program Quarterly Digest, Vol. 3, No. 2, April 1–June 30, 1963; $5.00 per yr. (Euratom)
19578	18-46	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19582	18-479	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19590	18-862	Dep.(mc); $2.60(fs), $0.95(mf) OTS
19594	18-1024	Dep.(mc); $5.60(fs), $1.88(mf) OTS
19596	18-404	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19599	18-2	Dep.(mc); $2.60(fs), $0.89(mf) OTS
19604	18-863	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19610	18-733	Dep.(mc); $2.60(fs), $0.98(mf) OTS
19617	18-47	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19618	18-9	Dep.(mc); $15.00(fs), $6.98(mf) OTS
19618(App.A)	18-12	
19618(App.B)	18-171	
19618(App.D)	18-3	
19618(App.E)	18-419	
19632	18-209	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19634	18-210	Dep.(mc); $1.60(fs), $0.80(mf) OTS
TM–	**(Misc.)**	
62-11-707	18-1244	See IDO-19313
TPR-NS–		
Vol.5, No.1	18-464	Nuclear Safety. Volume 5, No. 1, Fall 1963; (GPO) $0.55 (domestic), $0.70 (foreign)
TRG-Inf. Ser.–	**(British)**	
330	18-554	Dep.
TRG-Report–	**(Non-AEC)**	
438	18-211	Dep.; $0.90(BIS); 4s. 6d. (HMSO)
UCRL–		
6801	18-1218	Dep.; $1.00(OTS)
7310	18-1048	Nucl. Phys., 47: 521-4(1963)
7332-T	18-874	Nucl. Phys., 47: 367-84(1963)
7388	18-580	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10243	18-864	Dep.(mc); $2.60(fs), $0.83(mf) OTS
10646	18-612	Acta Met., 11: 994-5(1963)
10731	18-865	Dep.; $1.25(OTS)
10826	18-896	Phys. Rev. Letters, 11: 234-7(1963)
10841	18-212	$1.10(fs), $0.80(mf) OTS
10848	18-213	Dep.; $3.00(OTS)
10949	18-866	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-Conf-63-048-116
10965	18-1025	Dep.; $2.25(OTS)
13092	18-659	Dep.(mc); $8.60(fs), $3.17(mf) OTS
UCRL-Trans–		
962(L)	18-215	Dep.(mc); $2.60(fs), $0.92(mf) JCL
UNC–	**(Misc.)**	
5065	18-610	Dep.(mc); $4.60(fs), $1.58(mf) OTS
USAELRDL-TR–	**(Non-AEC)**	
2320	18-660	$2.60(OTS)
USNRDL-TR–	**(Non-AEC)**	
670	18-48	$1.60(OTS)
671	18-274	$1.60(OTS)
WAPD-PWR–		
TE-157	18-1259	Dep.(mc); $1.10(fs), $0.80(mf) OTS
WAPD-T–		
1584	18-988	J. Chem. Phys., 39: 2283-92(1963)
1590	18-539	Math. Computation, 17: 279-82(1963)
WCAP–	**(Misc.)**	
2361	18-1260	Dep.(mc); $12.00(fs), $5.03(mf) OTS
WW-R–	**(Dutch)**	
24	18-1175	See EURAEC-504
ZFK-PHA–	**(German)**	
7	18-495	
9	18-1026	Dep.(mc)

Appendix I

SUBJECT SCOPE OF NUCLEAR SCIENCE ABSTRACTS

Nuclear science is the study of the production, properties, principles, and phenomena of atomic nuclei, sub-atomic particles, and gamma and x radiation. Nuclear technology is the application of the principles and phenomena of nuclear science to the fields of science and engineering, and, conversely, the application of other science and engineering to the problems of nuclear science. These definitions however require further refinement to permit the user to determine exactly what *NSA* covers and also to permit uncontested selection or rejection of any piece of literature for *NSA*. Material selected for *NSA* is based solely on its subject content regardless of its form, origin, or language. The subject matter for *NSA* lies in 16 major subject fields, the limits of which are stated in the following scope notes. The specific interest in each of the elements is given in the second part of these notes.

Subject Fields of Interest

BIOLOGY AND MEDICINE

Ecological studies of radioactive materials

Metabolism, tissue distribution, and toxicology of all radioisotopes, of the actinides (including actinium), and of the fission-product elements strontium, iodine, barium, and cesium

Radiation-effects studies (particle, x ray, gamma ray, and ultraviolet) in all fields of biology, including second- and third-generation effects

Radiation hazards and protection

Radiation sickness

Radiotherapy and radiodiagnosis only if new equipment or techniques are used or if radiation side effects are discussed

Tracer studies if the isotope itself is the object of study or if the information on the tracer technique is new

CHEMISTRY

All chemistry of actual or simulated fission products and of actinides (including actinium)

Analysis, determination, and separation of lanthanides (including lanthanum)

Chemical methods for separating isotopes

Chemical stability of reactor moderators, fuels, coolants, control elements, and structures in storage or under accidental conditions, such as fire, flooding, or transport accidents

Chemistry involved in the preparation and use of radiation targets

Chemistry of compounds of noble or inert gases, including preparation or attempted preparation

Chemistry of radioactive waste processing, storage, and disposal

Chemistry of reactor coolants, moderators, and fuels
Corrosion and erosion in reactor fuel processing and waste disposal
Corrosion and erosion under actual or simulated reactor conditions
Isotope effects on chemical properties and reactions
Isotopic labeling of chemical compounds
Laboratory techniques for studying and processing thorium and uranium minerals
Radiation chemistry, radiochemistry, and radioanalytical techniques and equipment
Radioactive decontamination
Separation chemistry of reactor fuels and breeding blankets

ENGINEERING

Control engineering and automated systems applied to nuclear facilities, plants, or laboratories
Design and construction of laboratories, pilot plants, plant facilities, and equipment for handling and processing radioactive materials, reactor fuel and blanket materials, or feed materials (beginning with UO_3)
Design and construction of structures for protection against the effects of nuclear explosions
Engineering applications of, and seismological studies associated with, nuclear or simulated nuclear explosions
Heat-transfer and fluid-flow studies applied to nuclear facilities, plants, or laboratories
Magnetofluiddynamic flow
Materials testing limited to applications in nuclear technology or to new techniques involving nuclear phenomena
Ultrahigh vacuum engineering, i.e., 10^{-9} torr or greater, and other vacuum engineering as applied to accelerators or to thermonuclear devices

GEOLOGY AND MINERALOGY

Engineering applications of nuclear or simulated nuclear explosions
Geology studies for the selection of reactor, weapons-test, and waste-disposal sites
Hydrological studies involving movement of radioactive waste and fallout
Identification and description of new thorium and uranium minerals
Laboratory techniques for studying and processing thorium and uranium minerals
New radiometric techniques and equipment, including those used for geological-age determination and well logging
Seismology associated with nuclear or simulated nuclear explosions or with site selection
Studies of natural radioactivity

HEALTH AND SAFETY

All factors concerned with radiation incidents or with accidents involving radioactive materials, including decontamination
Maximum permissible concentrations of radioactive materials
Protective measures and equipment, safety procedures, and criticality and hazards studies associated with reactors or radiations
Radiation-dosage determinations, limits, and standards
Safety regulations and limits for handling, processing, storing, and transporting fissionable and radioactive materials

INSTRUMENTATION

Design, development, construction, testing, theory, and evaluation of radiation-detection instruments and systems
Instrumentation, in addition to that for radiation detection, only if directly applied in nuclear technology
Radiation effects on instruments and components

ISOTOPE TECHNOLOGY

Isotope effects on the physical and chemical properties of matter
Methods for labeling compounds
Preparing, handling, and storing radiation sources and radioisotopes
Production and separation of isotopes (stable and radioactive)
Tracer studies only if the isotope itself is the object of study or if the information on the tracer technique is new
Use of isotopes or fission products as radiation sources or power sources except in routine applications (e.g., routine laboratory, industrial, and medical uses)

MATHEMATICS AND COMPUTERS

Applications of computers, codes, and mathematical methods to the solution of nuclear-science problems

METALLURGY AND CERAMICS

Corrosion and erosion in reactor fuel processing and waste disposal
Corrosion and erosion under actual or simulated reactor conditions
Metallurgical studies on elements and their alloys and systems for reactor, accelerator, or other nuclear applications
Metallurgy of the actinides, the lanthanides, and the elements beryllium, niobium, technetium, yttrium, and zirconium, including the metallurgy of their alloys, compounds, and systems
Radiation effects on materials
Studies on ceramics, refractories, and cermets for reactor, accelerator, or other nuclear applications

METEOROLOGY

Meteorological studies for the selection of reactor and explosion test sites
Radioactive aerosol and gas production, dispersal, precipitation, agglomeration, and stack disposal
Radioactive fallout
Radioactivity in the atmosphere

NUCLEAR EXPLOSIONS

All scientific and technical aspects of actual or simulated nuclear explosions

PHYSICS

Accelerators (not including propulsion devices)
- All scientific and technical aspects, including the ion source

Astrophysics
- Cosmic origin and abundance of elements and isotopes
- Nuclear reaction in stars
- Solar phenomena only if plasma, particle kinetics, or magnetofluiddynamic aspects are discussed

Cosmic Radiation
- All scientific and technical aspects

Cryogenics
- As applied to nuclear science
- Involving nuclear phenomena or techniques

Direct Energy Conversion
- Any study involving nuclear phenomena or techniques
- Other studies limited to magnetofluiddynamic, plasma, and thermionic devices and applications of thermoelectric devices to reactor or other nuclear facilities

Geophysics
- High-altitude nuclear detonations and effects
- Particle kinetics and geomagnetic trapping in radiation belts
- Particle phenomena resulting from solar-storm interactions with the earth's magnetic field
- Seismic studies for the detection of nuclear explosions

Nuclear Physics
- Absorption, interaction, and scattering of gamma and x radiation
- Acceleration and nuclear reactions of ions, e.g., C^{14} ions
- All properties, reactions, and phenomena associated with the nucleus, either experimental or theoretical
- All scientific and technical aspects of elementary particles
- Electron-paramagnetic-resonance and nuclear-magnetic-resonance studies when the technique is the object of study
- Mössbauer-effect studies when the technique is the object of study

Plasma Physics
- Effects of electric or magnetic fields on plasma oscillations and particle dynamics
- Electromagnetic radiation emitted by ionized gases, e.g., cyclotron radiation
- Magnetofluiddynamics
- Motions and reactions of particles in electric and magnetic fields, excluding electron-tube and arc phenomena
- Production, properties, containment, and heating of plasma, excluding electron-tube plasma and routine applications of arc plasma
- Shock-produced plasma, excluding atmospheric re-entry and exploding-wire phenomena
- Theory, design, development, and experimentation (including ionization studies) relating to controlled fusion

Shielding
- All aspects of shielding against ionizing radiation, neutrons, and accelerated particles

Thermal shielding for reactors and for protection against nuclear explosions

Solid-State Physics
Limited to radiation effects, radiation detectors, and nuclear and reactor applications

Superconductivity
All scientific and technical aspects

Vacuum Technology
Ultrahigh vacuum (10^{-9} torr or greater)
Vacuum-technology applications to accelerators or to thermonuclear devices

RADIATION EFFECTS

All effects of particles (including ions) or of x or gamma radiation
Only biological effects of ultraviolet radiation
Thermal-radiation effects only if associated with nuclear explosions

RADIATION-RESISTANT MATERIALS

All scientific and technical aspects

REACTOR TECHNOLOGY

All scientific, technical, and economic aspects of nuclear fission and fusion reactors, including feasibility studies and site selection
Design, development, and testing of nuclear power plants and of components modified because of the reactor
Reactor theory, including neutron physics, criticality studies, reactor criticality effects of any element, and reactor control

WASTE DISPOSAL AND PROCESSING

All scientific and technical information dealing with radioactive waste

Extent of Interest in the Elements

ACTINIUM
All scientific and technical aspects

ALUMINUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

AMERICIUM
All scientific and technical aspects

ANTIMONY
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ARGON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ARSENIC
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes

Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ASTATINE
All scientific and technical aspects

BARIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BERKELIUM
All scientific and technical aspects

BERYLLIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BISMUTH
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BORON
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

BROMINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CADMIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CALCIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CALIFORNIUM
All scientific and technical aspects

CARBON
Applications of the element or its compounds or systems in nuclear technology or the

behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Properties and fabrication of nuclear-grade graphite and graphite fuel materials
Radiation effects
Radiochemistry

CERIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CESIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CHLORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine application as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CHROMIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

COBALT
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

COPPER
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

CURIUM
All scientific and technical aspects

DYSPROSIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes

Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EINSTEINIUM
All scientific and technical aspects

ERBIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

EUROPIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FERMIUM
All scientific and technical aspects

FLUORINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

FRANCIUM
All scientific and technical aspects

GADOLINIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GALLIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GERMANIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

GOLD
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HAFNIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HELIUM
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HOLMIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

HYDROGEN
Applications of the element or its compounds and systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of deuterium and tritium
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

INDIUM
Applications of the element and its alloys, compounds, and systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IODINE
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IRIDIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

IRON
Applications of the element and its alloys or systems, including steel and stainless steel, in nuclear technology or the behavior of the element, its alloys, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

KRYPTON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Chemistry of any compounds (e.g., KrF_2 or KrF_4), including preparation or attempted preparation
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LANTHANUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LAWRENCIUM (103)
All scientific and technical information

LEAD
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LITHIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

LUTETIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MAGNESIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MANGANESE
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions

Radiation effects
Radiochemistry

MENDELEVIUM
All scientific and technical aspects

MERCURY
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

MOLYBDENUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEODYMIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NEPTUNIUM
All scientific and technical aspects

NICKEL
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NIOBIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NITROGEN
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

NOBELIUM
All scientific and technical aspects

OSMIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

OXYGEN
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PALLADIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PHOSPHORUS
- Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PLATINUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PLUTONIUM
- All scientific and technical aspects

POLONIUM
- All scientific and technical aspects

POTASSIUM
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PRASEODYMIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
- Isotopes (excluding routine applications as tracers or radiation sources)
- Metabolism, tissue distribution, and toxicology of radioisotopes
- Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
- Nuclear properties and nuclear reactions
- Radiation effects
- Radiochemistry

PROMETHIUM
- Analysis, determination, and separation
- Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

PROTACTINIUM
All scientific and technical aspects

RADIUM
All scientific and technical aspects

RADON
All scientific and technical aspects

RHENIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RHODIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RUBIDIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

RUTHENIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SAMARIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SCANDIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SELENIUM
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SILICON
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SILVER
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SODIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

STRONTIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

SULFUR
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TANTALUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TECHNETIUM
All scientific and technical aspects

TELLURIUM
Applications of the element or its compounds or systems in nuclear technology or the behavior of the element, its compounds, or its systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TERBIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Radiation effects
Radiochemistry

THALLIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

THORIUM
All scientific and technical aspects except exploration, mining, ore processing, and routine industrial uses, e.g., thoriated cathodes

THULIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TIN
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TITANIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

TUNGSTEN
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

URANIUM
All scientific and technical aspects except exploration, mining, ore processing, and routine industrial applications

VANADIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

XENON
Applications of the element in nuclear technology or the behavior of the element in an actual or a simulated reactor environment
Chemistry of any compounds (e.g., XeF_4, XeF_6, or XeO_3), including preparation or attempted preparation

Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

YTTERBIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

YTTRIUM
Analysis, determination, and separation
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ZINC
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

ZIRCONIUM
Applications of the element or its alloys, compounds, or systems in nuclear technology or the behavior of the element, its alloys, compounds, or systems in an actual or a simulated reactor environment
Isotopes (excluding routine applications as tracers or radiation sources)
Metabolism, tissue distribution, and toxicology of radioisotopes
Metallurgy of the element or its alloys, compounds, or systems, excluding mineralogy
Nuclear properties and nuclear reactions
Radiation effects
Radiochemistry

Appendix II

NUCLEAR SCIENCE ABSTRACTS CATEGORY DEFINITIONS

BIOLOGY AND MEDICINE

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Ecology

Includes studies of the movement of radioactive and other materials through organisms and the environment and influence of these materials on natural communities. The measurement and hazards of radioactive materials in the biosphere are included in the subcategory *Radiation Hazards and Protection* of this subject category.

Metabolism, Tissue Distribution, and Toxicology

Includes chemical and metabolic processes in living organisms and the absorption, metabolism, utilization, and toxicological significance of materials ingested, inhaled, or otherwise absorbed by the organisms. Studies performed to establish maximum allowable concentrations of radioactive materials are included in the subcategory *Radiation Hazards and Protection* of this subject category.

Radiation Effects

Includes information on the effects of radiation on organisms or their components; this includes radiation sickness.

Radiation Effects Therapy and Countermeasures

Includes the use of biological extracts, chemical compounds, or drugs to alter, prevent, simulate, or treat the effects of radiation on organisms or their components. The use of special shields to prevent radiation effects is included in the subcategory *Radiation Hazards and Protection* of this subject category.

Radiation Hazards and Protection

Includes the measurement and hazards of radioactive material in the biosphere; studies of maximum permissible concentrations of radioactive materials on organisms or their components; and the use of rules, procedures, and equipment to reduce radiation exposure. Users of this subcategory should also see the subject category HEALTH AND SAFETY.

Radiotherapy and Radiodiagnosis

Includes the use of both external and internal radiation sources in the diagnosis and therapy of disease. Also includes all phases of radiation equipment, procedure, and effectiveness. For radiation side effects, see the subcategory *Radiation Effects* of this subject category.

CHEMISTRY

This category excludes *biochemistry*, which is found in the subcategory *Metabolism, Tissue Distribution, and Toxicology* of the subject category BIOLOGY AND MEDICINE; the subcategory *Corrosion* of the subject category METALS, CERAMICS, AND OTHER MATERIALS; and the subcategory *Geochemistry* of the subject category GEOLOGY AND MINERALOGY.

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Analytical Procedures

Includes both qualitative and quantitative procedures, radiochemical analysis, neutron-activation analysis, and mass-spectroscopy analysis.

Inorganic and Physical Chemistry

Includes the chemistry of elements and inorganic compounds and chemical thermodynamics. Other information on the chemistry of elements and inorganic compounds is included in the subcategories *Analytical Procedures*, *Radiation and Radiochemistry*, and *Separation Processes and Procedures* of this subject category and in the main subject category METALS, CERAMICS, AND OTHER MATERIALS. Radiation effects on chemical properties and reactions are included in the subcategory *Radiation Chemistry and Radiochemistry* of this subject category.

Organic Chemistry

Includes chemical and physical properties and reactions of organic compounds and systems of compounds. Equipment and procedures for investigating such properties and reactions are also included. For radiation effects on organic compounds, see the subcategory *Radiation Chemistry and Radiochemistry* of this subject category. Users of this subcategory should also see the subcategory *Separation Processes and Procedures* of this subject category.

Radiation Chemistry and Radiochemistry

Includes radiation effects on chemical properties and reactions, radiation effects on physical properties of nonmetallic elements and compounds and organic compounds, and special chemical procedures and equipment required as a result of the presence of radiation. Also includes the generation of visible light as a result of radiation. Radiation effects on biological materials are included in the subcategory *Radiation Effects* of the subject category BIOLOGY AND MEDICINE. Radiation effects on metals and intermetallic compounds are included in the subcategory *Radiation Effects* of the subject category METALS, CERAMICS, AND OTHER MATERIALS. Users of this subcategory should also see the subcategory *Separation Processes and Procedures* of this subject category and the main subject category WASTE DISPOSAL AND PROCESSING.

Separation Processes and Procedures

Includes the chemistry and chemical engineering for processing uranium and thorium ores and reactor fuel and breeder materials. Also includes chemical separations not designed for analytical purposes or for isotopic separations of an element. Analytical separations are included in the subcategory *Analytical Chemistry* of this subject category, and separations of isotopes of an element are included in the subcategory *Separation and Production* of the subject category ISOTOPE TECHNOLOGY.

ENGINEERING

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Applications of Nuclear Explosions

Includes engineering applications of nuclear explosions or simulated nuclear explosions.

Facilities and Equipment

Includes plants, plant facilities, and equipment not designed for specific application in one of the other categories.

Heat Transfer and Fluid Flow

Includes theoretical studies and engineering applications of heat transfer and fluid flow. For thermodynamics and magnetofluiddynamics, the user should see the subcategory *General and Miscellaneous* of the subject category PHYSICS.

Materials Testing

Limited to information primarily concerned with equipment, methods, and techniques for destructive or nondestructive testing of materials. When the material is of primary interest, information on testing (including corrosion and erosion) is included in the subject category METALS, CERAMICS, AND OTHER MATERIALS.

Protective Structures

Includes the design, construction, and effectiveness of blast and fallout shelters and other protective structures.

Vacuum Engineering

Includes the design and construction of vacuum systems and equipment (e.g., vacuum pumps). Excludes properties of materials under vacuum environment and vacuum systems and equipment that are more appropriately categorized according to the application (e.g., a vacuum system specifically intended for an accelerator is included in the subcategory *Accelerators* of the subject category PHYSICS).

GEOLOGY AND MINERALOGY

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Natural Radioactivity and Fallout

Includes ground levels and movement of radioactive materials, both natural and artificial, and elemental and isotopic compositions of minerals.

Site Survey and Selection

Includes reactor and plant site-selection studies.

Techniques and Equipment

Includes the use of radiometric techniques and equipment in geology, mineralogy, and seismology associated with nuclear-explosion detection.

Thorium and Uranium Minerals

Includes structures and properties of thorium and uranium minerals.

HEALTH AND SAFETY

Includes critical limits for moving and storing fissionable, radioactive, and toxic materials; experience in applied health physics; limits for external and internal emitters; the development of, and experience with, personnel-protection procedures; and general industrial- and radiation-hazards analyses. Excludes studies performed to establish maximum allowable concentrations and limits of exposure, which are included in the subcategory *Metabolism, Tissue Distribution, and Toxicology* of the subject category BIOLOGY AND MEDICINE.

INSTRUMENTATION

This category excludes information on the specific applications of an instrument, which is categorized by the subject of the application.

General

Includes information on the design, testing, and use of instruments, except radiation detection, where these aspects of instrumentation are the main subjects.

Radiation Detection

Includes information on radiation-detection instruments and their components.

ISOTOPE TECHNOLOGY

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Industrial Applications

Includes only applications to industrial processes and equipment for such applications. Applications to basic research are found under such categories as CHEMISTRY.

Power Application

Includes applications of radioisotopes in the production of electric or thermal energy or thrust.

Separation and Production

Includes the separation of isotopes of one element in microquantities or macroquantities. Separation of isotopes of different elements is included in the subcategory *Separation Processes and Procedures* of the subject category CHEMISTRY.

MATHEMATICS AND COMPUTERS

Includes information on pure mathematics; statistics; and the design, development, and operation of computers. Information on applied mathematics and computer applications is categorized according to the application (e.g., computers used as simulators

of various devices and processes are categorized in the same manner as the device or process simulated; computer codes and applied mathematics are categorized on the basis of the application).

METALS, CERAMICS, AND OTHER MATERIALS

The term "other materials" refers to such substances as plastics, rubbers, other elastomers, wood, concrete, graphite, and petroleum.

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Corrosion

Includes corrosion and erosion studies that appear to be directed toward specific applications. Excludes studies primarily concerned with physical chemistry, reaction kinetics, etc., which are included in the subject category CHEMISTRY.

Fabrication

Limited to fabrication methods, procedures, and equipment, including those for fuel elements and reactor components.

Properties and Structure

Includes mechanical, physical, and structural properties.

Radiation Effects

Includes effects of radiation on mechanical, physical, and structural properties. Chemical effects of radiation are included in the subcategory *Radiation Chemistry and Radiochemistry* of the subject category CHEMISTRY.

METEOROLOGY

Includes atmospheric and weather conditions, climatology, general meteorological problems, and meteorological studies made for the purpose of obtaining information on the movement of airborne particulate matter. Meteorology included in site-selection reports is contained in the subcategory *Site Survey and Selection* of the subject category GEOLOGY AND MINERALOGY.

PHYSICS

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Accelerators

Includes the theory, design, development, construction, and operation of high-voltage machines and particle accelerators.

Astrophysics and Cosmology

Includes the origin and cosmic abundance of elements, isotopic composition of meteorites, stellar processes, and stellar magnetic fields.

Atomic Physics

Includes physical properties and theory of atoms and their interactions, reactions, and scattering. Also includes the production of atomic beams and the effects and mechanisms of atomic beam bombardment of materials.

Cosmic Radiation

Includes studies of the origin, intensity variations, acceleration processes, etc., of cosmic radiation. For studies on the properties of specific cosmic particles or studies on the use of cosmic radiation merely as a source of high-energy particles, see the subcategories *Elementary Particles and Radiations* and *Nuclear Properties and Reactions* of this subject category, depending on the emphasis.

Criticality Studies

Includes basic studies of nuclear criticality. Critical limits of movement and storage of radioactive materials are included in the subject category HEALTH AND SAFETY. Criticality studies pertaining to reactors are included in the subject category REACTOR TECHNOLOGY.

Direct Energy Conversion

Includes equipment, techniques, and theory of direct-energy conversion, including magnetohydrodynamic cells and thermionic cells.

Elementary Particles and Radiations

Includes properties and theory, including interactions with each other. The diffusion of particles and radiations in shielding materials and configurations is included in the subcategory *Shielding* of this subject category.

Field Theory and Quantum Mechanics

Includes basic studies of the behavior and interactions of fields, the kinetics of field-matter systems, and the quantization of energy and energy transfer. Specific applications of field theory and quantum mechanics are found in other subcategories.

Geophysics

Includes geomagnetic fields, upper atmosphere physics, and physics of the crust and interior of the earth; this excludes cosmic radiation.

Low Temperature Physics

Includes cryogenics, superconductivity, and superfluidity research. Applications are found under categories for the applications.

Neutron Physics

Includes experimental and mathematical treatments of neutron absorption, attenuation, moderation, multiplication, scattering, etc., in real and hypothetical media. Such studies conducted for a specified application are categorized according to the application (e.g., the subject category REACTOR TECHNOLOGY and the subcategories *Criticality Studies* and *Shielding* of this subject category). Neutron reactions with specific nuclei are included in the subcategory *Nuclear Properties and Reactions* of this subject category.

Nuclear Properties and Reactions

Includes experimental and theoretical studies relating to properties, reactions, and interactions of nuclei.

Plasma Physics and Thermonuclear Processes

Includes phenomena of electric discharges; fundamental plasma experiments and theory; theory, design, development, and experimentation relating to controlled release of energy from thermonuclear reactions; and research and theory on electrodynamics and magnetodynamics applicable to plasma studies and thermonuclear processes.

Shielding

Limited to theoretical and experimental studies relating to the diffusion, attenuation, absorption, and scattering of particles and radiations in shielding materials and configurations. For information on the fabrication of shielding materials and configurations, see the subcategory *Fabrication* of the subject category METALS, CERAMICS, AND OTHER MATERIALS.

REACTOR TECHNOLOGY

General

Includes information which falls under the main subject category but which is outside specific subcategories or is a combination of two or more subcategories.

Auxiliaries and Components

Includes the design and construction of auxiliaries, components, control systems, and instrumentation not intended for a specific reactor.

Crititicality Studies

Includes theoretical and experimental studies of neutron physics and parameters of unspecified reactors.

Design and Feasibility

Includes design and feasibility studies of reactor types which are not designated as power, process heat, production, propulsion, research, or test and which are not associated with a specific reactor.

Fuels

Includes the design and theory of fuel elements not associated with a specific reactor. Studies of fuel-element materials are included in the subject category METALS, CERAMICS, AND OTHER MATERIALS.

Power and Power-Breeder Reactors

Includes the design, construction, feasibility, operation, and economics of specific reactors and classes of reactors. Also includes auxiliaries, components, and criticality studies for such reactors.

Process Heat Reactors

Includes reactors designed to produce heat for uses other than the production of electricity or propulsion. Reactors designed to produce electricity and process heat are included in the subcategory *Power and Power-breeder Reactors* of this subject category.

Production Reactors

Includes the design, construction, feasibility, economics, and operation of reactors devoted primarily to the production of fissionable materials or isotopes. Also includes auxiliaries, components, and criticality studies for such reactors.

Propulsion and Space

Includes the design, construction, feasibility, economics, and operation of reactors used for the propulsion of vehicles (land, water, air, and space). Also includes auxiliaries, components, and criticality studies for such reactors. The vehicles themselves are included only if the influence on the reactor is considered.

Research and Test Reactors

Includes the design, construction, feasibility, economics, and operation of reactors used for radiation-effects studies and other basic research. Also includes auxiliaries, components, and criticality studies for such reactors.

WASTE DISPOSAL AND PROCESSING

Includes the chemistry and chemical engineering processing for the storage, disposal, and control of radioactive waste materials, including the treatment of waste materials prior to disposal, such as concentration, neutralization, filtration, or calcination. Safety aspects of radioactive waste handling and disposal are included in the subject category HEALTH AND SAFETY. Ecological aspects of waste materials are included in the subcategory *Ecology* of the subject category BIOLOGY AND MEDICINE. Some radiochemical aspects are included in the subcategory *Radiochemistry* of the

subject category CHEMISTRY. Fuel-element processing is included in the subcategory *Separation Processes* of the subject category CHEMISTRY.

GENERAL AND MISCELLANEOUS

This category, for the most part, contains abstracts of research and development reports of the U. S. Atomic Energy Commission and its contractors which are essentially non-nuclear in nature or which are outside the scope of the other categories in *NSA*. Such abstracts have for the past year or so been included in *Research and Development Abstracts of the USAEC*. *RDA* was discontinued after issue number 8.

Additionally, both AEC and non-AEC orginated broad summary type documents with diverse subject matter will be found under this category.

Appendix III

JOURNALS REGULARLY SCANNED

Acad. Rep. Populare Romine, Baza Cercetari Stiint. Timisoara, Studii Cercetari Stiint. Ser. Stiinte Med.
Academia Republicii Populare Romine, Baza de Cercetari Stiintifice Timisoara, Studii si Cercetari Stiintifice. Seria Stiinte Medical *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Energet. Ser. A
Academia Republicii Populare Romine, Institutul de Energetica, Studii si Cercetari de Energetica. Seria A. Energetica Generala si Electroenergetica *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Energet. Ser. B
Academia Republicii Populare Romine, Institutul de Energetica, Studii si Cercetari de Energetica. Seria B. Termoenergetica si Utilizarea Energetica a Combustibililor *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Fiz.
Academia Republicii Populare Romine, Institutul de Fizica Atomica si Institutul de Fizica, Studii si Cercetari de Fizica *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Stiint. Ser. Stiinte Chim.
Academia Republicii Populare Romine, Studii si Cercetari Stiintifice. Seria Stiinte Chimice *(Romania)*

Acad. Rep. Populare Romine, Studii Cercetari Stiint. Ser. Stiinte Tehnice
Academia Republicii Populare Romine, Studii si Cercetari Stiintifice. Seria Stiinte Tehnice *(Romania)*

Acad. Roy. Belg. Classe Sci. Mem. Collection in 8°
Academie Royale de Belgique, Classe des Sciences Memoires Collection in 8° *(Belgium)*

Acta Anat.
Acta Anatomica *(Switzerland)*

Acta Biochim. Polon. (English Transl.)
Acta Biochimica Polonica (English Translation) *(Poland)*

Acta Chem. Scand.
Acta Chemica Scandinavica *(Denmark)*

Acta Chim. Acad. Sci. Hung.
Acta Chimica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Cryst.
Acta Crystallographica *(Denmark)*

Acta Cytol.
Acta Cytologica *(U. S.)*

Acta Gerontol.
Acta Gerontologica *(Italy)*

Acta Gynaecol. Obstet. Hispano Lusitana
Acta Gynaecologica et Obstetrica Hispano Lusitana *(Portugal)*

Acta Histochem.
Acta Histochemica *(Germany)*

Acta Med. Biol. (Niigata)
Acta Medica et Biologica (Niigata) *(Japan)*

Acta Med. Hidalguense
Acta Medica Hidalguense *(Mexico)*

Acta Med. Iranica
Acta Medica Iranica *(Iran)*

Acta Med. Okayama
Acta Medicinae Okayama *(Japan)*

Acta Med. Polona
Acta Medica Polona *(Poland)*

Acta Met.
Acta Metallurgica *(U. S.)*

Acta Neurol. Latinoam.
Acta Neurologia Latinoamericana *(Uruguay)*

Acta Neuropsiquiat. Arg.
Acta Neuropsiquiatrica Argentina *(Argentina)*

Acta Paediat.
Acta Paediatrica *(Sweden)*

Acta Pathol. Japon.
Acta Pathologica Japonica *(Japan)*

Acta Phys. Acad. Sci. Hung.
Acta Physica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Phys. Austriaca
Acta Physica Austriaca *(Austria)*

Acta Physiol. Polon.
Acta Physiologica Polonica *(Poland)*

Acta Physiol. Scand.
Acta Physiologica Scandinavica *(Sweden)*

Acta Phys. Polon.
Acta Physica Polonica *(Poland)*

Acta Phys. Sinica
Acta Physica Sinica
see Wu Li Hsueh Pao

Acta Polytech. Scand., Chem. Met. Ser.
Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series *(Denmark)*

Acta Radiol. Diagnosis
Acta Radiologica. Diagnosis *(Sweden)*

Acta Radiol. Therapy, Phys., Biol.
Acta Radiologica. Therapy, Physics, Biology *(Sweden)*

Acta Rheumatol. Scand.
Acta Rheumatologica Scandinavica *(Sweden)*

Actas Dermo-Sifilog.
Actas Dermo-Sifilograficas *(Spain)*

Acta Soc. Med. Upsalien.
Acta Societatis Medicorum Upsaliensis *(Sweden)*

Acta Tech. Acad. Sci. Hung.
Acta Technica Academiae Scientiarum Hungaricae *(Hungary)*

Acta Unio Intern. Contra Cancrum
Acta Unio Internationalis Contra Cancrum *(Belgium)*

Acta Virol. (Prague)
Acta Virologica (Prague) *(Czechoslovakia)*

Advan. Energy Conversion
Advanced Energy Conversion *(England)*

Advan. Phys.
Advances in Physics *(England)*

A E G Mitt.
A E G Mitteilungen *(Germany)*

AEI (Assoc. Elec. Ind.) Eng.
AEI (Associated Electrical Industries) Engineering *(England)*

Afrique Franc. Chir.
Afrique Francaise Chirurgicale *(Algeria)*

Aggiorn. Mal. Infezione
Aggiornamenti sulle Malattie da Infezione *(Italy)*

AIAA (Am. Inst. Aeron. Astronaut.) J.
AIAA (American Institute of Aeronautics and Astronautics) Journal (combining the ARS Journal and the Journal of Aerospace Sciences) *(U. S.)*

A.I.Ch.E. (Am. Inst. Chem. Engrs.) J.
A.I.Ch.E. (American Institute of Chemical Engineers) Journal *(U. S.)*

Air Eng.
Air Engineering *(U. S.)*

Alexandria Med. J.
Alexandria Medical Journal, The *(Egypt)*

Algerie Med.
Algerie Medicale *(Algeria)*

Am. Ceram. Soc. Bull.
American Ceramic Society Bulletin, The *(U. S.)*

Am. Ind. Hyg. Assoc. J.
American Industrial Hygiene Association Journal *(U. S.)*

Am. J. Botany
American Journal of Botany *(U. S.)*

Am. J. Clin. Pathol.
American Journal of Clinical Pathology *(U. S.)*

Am. J. Pathol.
American Journal of Pathology, The *(U. S.)*

Am. J. Phys.
American Journal of Physics *(U. S.)*

Am. J. Physiol.
American Journal of Physiology, The *(U. S.)*

Am. J. Roentgenol., Radium Therapy Nucl. Med.
American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, The *(U. S.)*

Am. Mineralogist
American Mineralogist, The *(U. S.)*

Am. Soc. Metals, Trans. Quart.
American Society for Metals, Transactions Quarterly *(U. S.)*

Anais Acad. Brasil. Cienc.
Anais da Academia Brasileira de Ciencias *(Brazil)*

Anais Brasil. Dermatol. Sifilog.
Anais Brasileiros de Dermatologia e Sifilografia *(Brazil)*

Anais Brasil. Ginecol. (Rio de Janeiro)
Anais Brasileiros de Ginecologia (Rio de Janeiro) *(Brazil)*

Anais Inst. Med. Trop. (Lisbon)
Anais Instituto de Medicina Tropical (Lisbon) *(Portugal)*

Anal. Biochem.
Analytical Biochemistry *(U. S.)*

Anal. Chem.
Analytical Chemistry *(U. S.)*

Anal. Chim. Acta
Analytica Chimica Acta *(Netherlands)*

Anales Hosp. Militar Central (Lima, Peru)
Anales del Hospital Militar Central (Lima, Peru) *(Peru)*

Anales Inst. Corachan (Barcelona)
Anales del Instituto Corachan (Barcelona) *(Spain)*

Anales Inst. Oncol. "Angel H. Roffo"
Anales del Instituto de Oncologia "Angel H. Roffo" *(Argentina)*

Anales Med. Cir.
Anales de Medicina y Cirugia *(Spain)*

Anales Real Acad. Nacl. Med. (Madrid)
Anales de la Real Academia Nacional de Medicina (Madrid) *(Spain)*

Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A
Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie A *(Spain)*

Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B
Anales de la Real Sociedad Espanola de Fisica y Quimica (Madrid), Serie B *(Spain)*

Analyst
Analyst, The *(England)*

Angiologia (Barcelona)
Angiologia (Barcelona) *(Spain)*

Ann. Acad. Sci. Fennicae, Ser. A II
Annales Academiae Scientiarum Fennicae, Series A II. Chemica *(Finland)*

Ann. Acad. Sci. Fennicae, Ser. A VI
Annales Academiae Scientiarum Fennicae, Series A VI. Physica *(Finland)*

Ann. Allergy
Annals of Allergy *(U. S.)*

Ann. Biochem. Exptl. Med. (Calcutta)
Annals of Biochemistry and Experimental Medicine (Calcutta) *(India)*

Ann. Chir. Gynaecol. Fenniae
Annales Chirurgiae et Gynaecologie Fenniae *(Finland)*

Ann. Inst. Henri Poincare
Annales de l'Institut Henri Poincare *(France)*

Ann. Intern. Geophys. Yr.
Annals of the International Geophysical Year *(England)*

Ann. Ostet. Ginecol.
Annali di Ostetricia e Ginecologia *(Italy)*

Ann. Paediat. Fenniae
Annales Paediatriae Fenniae *(Finland)*

Ann. Paediat. Japon.
Annales Paediatrici Japonici, Kioto Universitatis *(Japan)*

Ann. Phys. (N. Y.)
Annals of Physics (New York) *(U. S.)*

Ann. Phys. (Paris)
Annales de Physique (Paris) *(France)*

Ann. Physik
Annalen der Physik *(Germany)*

Ann. Radiol.
Annales de Radiologie *(France)*

Ann. Rept. Radiation Center Osaka Prefect.
Annual Report of the Radiation Center of Osaka Prefecture *(Japan)*

Ann. Rev. Nucl. Sci.
Annual Review of Nuclear Science *(U. S.)*

Ann. Rev. Phys. Chem.
Annual Review of Physical Chemistry *(U. S.)*

Ann. Rheumatic Diseases
Annals of the Rheumatic Diseases *(England)*

Ann. Sclavo
Annali Sclavo *(Italy)*

Ann. Soc. Sci. Bruxelles. Ser. I
Annales de la Societe Scientifique de Bruxelles. Serie I *(Belgium)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. A
Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio A *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. AA
Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio AA *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. B
Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio B *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. C
Annales Universitatis Mariae Curie-Sklodowska, Lubin-Polonia, Sectio C *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. D
Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio D *(Poland)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Polonia, Sect. E
Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio E *(Poland)*

Anotaciones Pediat. (Medellin, Colombia)
Anotaciones Pediatricas (Medellin, Colombia) *(Colombia)*

APCA (Air Pollution Control Assoc.) Abstr.
APCA (Air Pollution Control Association) Abstracts *(U. S.)*

Appl. Mech. Rev.
Applied Mechanics Reviews *(U. S.)*

Appl. Opt.
Applied Optics *(U. S.)*

Appl. Phys. Letters
Applied Physics Letters *(U. S.)*
Appl. Sci. Res., Sect. A
Applied Scientific Research, Section A *(Netherlands)*
Appl. Sci. Res., Sect. B
Applied Scientific Research, Section B *(Netherlands)*
Appl. Spectry.
Applied Spectroscopy *(U. S.)*
Arch. Anat. Microscop. Morphol. Exptl.
Archives d'Anatomie Microscopique et de Morphologie Experimentale *(France)*
Arch. Biochem. Biophys.
Archives of Biochemistry and Biophysics *(U. S.)*
Arch. Biol. (Liege)
Archives de Biologie (Liege) *(Belgium)*
Arch. Bodowy Maszyn
Archiwum Bodowy Maszyn *(Poland)*
Arch. Col. Med. El Salvador
Archivos del Colegio Medico de El Salvador *(El Salvador)*
Arch. Environ. Health
Archives of Environmental Health (formerly A.M.A. Archives of Industrial Health) *(U. S.)*
Arch. Hosp. Univ. (Havana)
Archivos de Hospitales Universitarios (Havana) (formerly Archivos del Hospital Universitario) *(Cuba)*
Arch. Hosp. Vargas (Caracas)
Archivos del Hospital Vargas (Caracas) *(Venezuela)*
Arch. Hutnictwa
Archiwum Hutnictwa *(Poland)*
Arch. Hyg. Bakteriol.
Archiv fuer Hygiene und Bakteriologie *(Germany)*
Arch. Interam. Rheumatol.
Archives of Interamerican Rheumatology *(Brazil)*
Arch. Intern. Pharmacodyn.
Archives Internationales de Pharmacodynamie et de Therapie *(Belgium)*
Arch. Ital. Biol.
Archives Italiennes de Biologie *(Italy)*
Arch. Mech. Stosowanej
Archiwum Mechaniki Stosowanej *(Poland)*
Arch. Med. Mex.
Archivos Medicos Mexicanos *(Mexico)*
Arch. Peru. Patol. Clin. (Lima)
Archivos Peruanos de Pathologia y Clinica (Lima) *(Peru)*
Arch. Roumaines Pathol. Exptl. Microbiol.
Archives Roumaines de Pathologie Experimentale et de Microbiologie *(France)*
Arch. Sci. (Geneva)
Archives des Sciences (Geneva) *(Switzerland)*
Arch. Soc. Estud. Clin. Habana
Archivos de la Sociedad de Estudios Clinicos de la Habana *(Cuba)*
Arch. Venezolanos Med. Trop. Parasitol. Med.
Archivos Venezolanos de Patologia Tropical y Parasitologia Medica *(Venezuela)*
Argonne Natl. Lab. News-Bull. Intern.
Argonne National Laboratory News-Bulletin International *see News-Bull. Intern. (Argonne Natl. Lab.)*
Arkiv Fysik
Arkiv for Fysik *(Sweden)*
Arquiv. Brasil. Cardiol.
Arquivos Brasileiros de Cardiologia *(Brazil)*
Arquiv. Dermatol. Sifilig. Sao Paulo
Arquivos de Dermatologia e Sifiligrafia de Sao Paulo *(Brazil)*
Arquiv. I.B.I.T. (Inst. Brasil. Invest. Tuberc.)
Arquivos do I.B.I.T. (Instituto Brasileiro para Investigacao da Tuberculose) *(Brazil)*
Arquiv. Mineiros Leprol.
Arquivos Mineiros de Leprologia *(Brazil)*
Arquiv. Patol. (Lisbon)
Arquivos de Patologia (Lisbon) *(Portugal)*
Arquiv. Tisiol.
Arquivos de Tisiologia *(Portugal)*
Arthritis Rheumat.
Arthritis and Rheumatism *(U. S.)*
Astronaut. Acta
Astronautica Acta *(Austria)*
Astronaut. Aerospace Eng.
Astronautics and Aerospace Engineering (combining Astronautics and Aerospace Engineering) *(U. S.)*
Astrophys. J.
Astrophysical Journal, The *(U. S.)*
Ateneo Parmense
Ateneo Parmense, L' *(Italy)*
At. Energ. (USSR)
Atomnaya Energiya† *(U.S.S.R.)*
At. Energy
Atomic Energy *(Australia)*
Atomes (Paris)
Atomes (Paris) *(France)*
Atomics
Atomics *(U. S.)*
Atomkernenergie
Atomkernenergie (formerly Atomenergie) *(Germany)*
Atomlight
Atomlight *(U. S.)*
Atompraxis
Atompraxis *(Germany)*
Atomwirtschaft
Atomwirtschaft, Die *(Germany)*
Atoomenergie Haar Toepassingen
Atoomenergie en Haar Toepassingen (formerly RCN Bulletin) *(Netherlands)*
At. Strom.
Atom und Strom *(Germany)*
Atti Accad. Nazl. Lincei, Rend., Classe Sci. Fis., Mat. Nat.
Atti della Accademia Nazionale dei Lincei. Rendiconti, Classe di Scienze Fisiche, Matematiche e Naturali *(Italy)*
Atti Accad. Sci. Torino: I. Classe Sci. Fis., Mat. Nat.
Atti della Accademia delle Scienze di Torino. Part I. Classe Scienze Fisiche, Matematiche e Naturali *(Italy)*
Atti Assoc. Genet. Ital.
Atti Associazone Genetica Italiana *(Italy)*
Atti Soc. Nat. Mat. Modena
Atti della Societa dei Naturalisti e Matematici di Modena *(Italy)*
Australian J. Appl. Sci.
Australian Journal of Applied Science *(Australia)*
Australian J. Chem.
Australian Journal of Chemistry *(Australia)*
Australian J. Phys.
Australian Journal of Physics *(Australia)*
Automazione Automatismi
Automazione e Automatismi *(Italy)*
Automazione Strumentazione
Automazione e Strumentazione *(Italy)*
Bacteriol. Rev.
Bacteriological Reviews *(U. S.)*
Battelle Tech. Rev.
Battelle Technical Review *(U. S.)*
Beitr. Pathol. Anat. Allgem. Pathol.
Beitraege zur Pathologischen Anatomie und zur Allgemeinen Pathologie *(Germany)*
Ber. Oberhess. Ges. Natur- Heilk. Giessen, Naturw. Abt.
Bericht der Oberhessischen Gesellschaft fuer Natur- und Heilkunde zu Giessen, Naturwissenschaftliche Abteilung *(Germany)*
Biochem. Biophys. Res. Commun.
Biochemical and Biophysical Research Communications *(U. S.)*
Biochemistry
Biochemistry *(U. S.)*

Biochemistry (USSR) (English Transl.)
Biochemistry (USSR) (English Translation of Biokhimiya) *(U. S.)*

Biochem. J.
Biochemical Journal *(England)*

Biochem. Pharmacol.
Biochemical Pharmacology *(England)*

Biochim. Biophys. Acta
Biochimica et Biophysica Acta *(U. S.)*

Biol. Neonatorum
Biologia Neonatorum *(Switzerland)*

Bio-Med. Purview
Bio-Medical Purview *(U. S.)*

Biophysics (USSR) (English Transl.)
Biophysics (USSR) (English Translation of Biofizika) *(England)*

Biophys. J.
Biophysical Journal *(U. S.)*

Blood
Blood. The Journal of Hematology *(U. S.)*

Bol. Asoc. Med. Puerto Rico
Boletin de la Asociacion Medica de Puerto Rico *(Puerto Rico)*

Bol. Hosp. Oftalmol. Nuestra Senora de la Luz
Boletin del Hospital Oftalmologico de Nuestra Senora de la Luz *(Mexico)*

Bol. Inform. Junta Control Energia At. (Peru)
Boletin de Informaciones de la Junta de Control de Energia Atomica *(Peru)*

Bol. Inst. Estud. Med. Biol. (Mex.)
Boletin del Instituto de Estudios Medicos y Biologicos *(Mexico)*

Boll. Ist. Sieroterap. Milan.
Bollettino dell'Istituto Sieroterapico Milanese *(Italy)*

Bol. Soc. Cubana Dermatol. Sifilog.
Boletin de la Sociedad Cubana de Dermatologia y Sifilografia *(Cuba)*

Bol. Soc. Med. Centro Materno "Gral. Maximino Avila Camacho"
Boletin de la Sociedad Medica del Centro Maternoo "Gral. Maximino Avila Camacho" *(Mexico)*

Bol. Trab. Soc. Cir. Buenos Aires
Boletines y Trabajos; Sociedad de Cirugia de Buenos Aires *(Argentina)*

Bol. Univ. Parana, Fis. Teorica
Boletim da Universidade do Parana, Fisica Teorica *(Brazil)*

Brennstoff-Waerme-Kraft
Brennstoff-Waerme-Kraft *(Germany)*

Brit. Chem. Eng.
British Chemical Engineering *(England)*

Brit. J. Appl. Phys.
British Journal of Applied Physics *(England)*

Brit. J. Cancer
British Journal of Cancer *(England)*

Brit. J. Radiol.
British Journal of Radiology *(England)*

Brown Boveri Rev.
Brown Boveri Review, The *(Switzerland)*

Bul. Inst. Politeh. Bucuresti
Buletinul Institutului Politehnic Bucuresti *(Romania)*

Bul. Inst. Politeh. Iasi
Buletinul Institutului Politehnic din Iasi *(Romania)*

Bull. Acad. Polon. Sci., Ser. Sci. Chim.
Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Chimiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys.
Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences, Mathematiques, Astronomiques et Physiques *(Poland)*

Bull. Acad. Polon. Sci., Ser. Sci., Tech.
Bulletin de l'Academie Polonaise des Sciences, Serie des Sciences Techniques *(Poland)*

Bull. Atmospheric Radioactivity (Japan)
Bulletin of the Atmospheric Radioactivity (Japan)

Bull. Chem. Soc. Japan
Bulletin of the Chemical Society of Japan *(Japan)*

Bull. Classe Sci., Acad. Roy. Belg.
Bulletin de la Classe des Sciences, Academie Royale de Belgique *(Belgium)*

Bull. Electrotech. Lab. (Tokyo)
Bulletin of the Electrotechnical Laboratory (Tokyo) *see Denki Shikensho Iho*

Bull. Heart Inst., Japan
Bulletin of the Heart Institute, Japan *(Japan)*

Bull. Hosp. Joint Diseases
Bulletin of the Hospital for Joint Diseases *(U. S.)*

Bull. Inform. Assoc. Belge Develop. Pacifique Energie At.
Bulletin d'Information de l'Association Belge pour le Developpement Pacifique de l'Energie Atomique *(Belgium)*

Bull. Inform. Sci. Tech. (Paris)
Bulletin d'Information Scientifique et Technique (Paris) *(France)*

Bull. Inst. Chem. Acad. Sinica
Bulletin of the Institute of Chemistry, Academia Sinica *(China)*

Bull. Inst. Chem. Res., Kyoto Univ.
Bulletin of the Institute for Chemical Research, Kyoto University *(Japan)*

Bull. Inst. Nucl. Sci. "Boris Kidrich" (Belgrade)
Bulletin of the Institute of Nuclear Science "Boris Kidrich" (Belgrade) *(Yugoslavia)*

Bull. Res. Council Israel, Sect. A
Bulletin of the Research Council of Israel, Section A. Chemistry *(Israel)*

Bull. Res. Council Israel, Sect. C
Bulletin of the Research Council of Israel, Section C. Technology *(Israel)*

Bull. Res. Council Israel, Sect. F
Bulletin of the Research Council of Israel, Section F. Mathematics and Physics *(Israel)*

Bull. Rheumatic Diseases
Bulletin on Rheumatic Diseases *(U. S.)*

Bull. Schweiz. Akad. Med. Wiss.
Bulletin der Schweizerischen Akademie der Medizinischen Wissenschaften *(Switzerland)*

Bull. Sci., Conseil Acad. RPF Yougoslavie
Bulletin Scientifique, Conseil des Academies de la RPF Yougoslavie *(Yugoslavia)*

Bull. Sci. Res. Inst. (Seoul, Korea)
Bulletin of the Scientific Research Institute (Seoul, Korea) *see Kwayon Hwibo*

Bull. Soc. Chim. Belges
Bulletin des Societes Chimiques Belges *(Belgium)*

Bull. Soc. Chim. France
Bulletin de la Societe Chimique de France *(France)*

Bull. Soc. Roy. Belge Gynecol. Obstet.
Bulletin de la Societe Royale Belge de Gynecologie et d'Obstetrique *(Belgium)*

Bull. Soc. Roy. Sci. Liege
Bulletin de la Societe Royale des Sciences de Liege *(Belgium)*

Bunseki Kagaku
Bunseki Kagaku (Japan Analyst) *(Japan)*

Burma Med. J.
Burma Medical Journal *(Burma)*

Calif. Med.
California Medicine *(U. S.)*

Cancer
Cancer *(U. S.)*

Cancer Res.
Cancer Research *(U. S.)*

Can. J. Biochem. Physiol.
Canadian Journal of Biochemistry and Physiology (formerly Canadian Journal of Medical Sciences) *(Canada)*

Can. J. Chem.
Canadian Journal of Chemistry *(Canada)*

Can. J. Chem. Eng.
Canadian Journal of Chemical Engineering (formerly Canadian Journal of Technology) *(Canada)*
Can. J. Genet. Cytol.
Canadian Journal of Genetics and Cytology *(Canada)*
Can. J. Phys.
Canadian Journal of Physics *(Canada)*
Can. Met. Quart.
Canadian Metallurgical Quarterly *(Canada)*
Can. Nucl. Technol.
Canadian Nuclear Technology *(Canada)*
Cardiologia
Cardiologia *(Switzerland)*
CENUSA (Bol. Centrales Nucl., Soc. Anon.)
CENUSA (Boletin de Centrales Nucleares, Sociedad Anonima) *(Spain)*
CERN Courier
CERN Courier *(Switzerland)*
Cesk. Casopis Fys.
Ceskoslovensky Casopis pro Fysiku *(Czechoslovakia)*
Chem. Anal. (Warsaw)
Chemia Analityczna (Warsaw) *(Poland)*
Chem. Eng. Progr.
Chemical Engineering Progress *(U. S.)*
Chem. Eng. Sci.
Chemical Engineering Science *(U. S.)*
Chem. High Polymers (Tokyo)
Chemistry of High Polymers (Tokyo)
see *Kobunshi Kagaku*
Chemist-Analyst
Chemist-Analyst, The *(U. S.)*
Chem. Process Eng.
Chemical & Process Engineering (including Atomic World) *(England)*
Chem. Rev.
Chemical Reviews *(U. S.)*
Chem. Tech. (Leipzig)
Chemische Technik, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig *(Germany)*
Ciencia Tec. (Buenos Aires)
Ciencia y Tecnica (Buenos Aires) *(Argentina)*
Cir. Cirujanos
Cirurgia y Cirujanos *(Mexico)*
Cir. Ginecol. Urol.
Cirugia, Ginecologia, y Urologia *(Spain)*
Clin. Chem.
Clinical Chemistry *(U. S.)*
Clin. Chim. Acta
Clinica Chimica Acta *(Netherlands)*
Clin. Res.
Clinical Research *(U. S.)*
Cobalt
Cobalt *(Belgium) (U. S.)*
Collection Czech. Chem. Commun.
Collection of Czechoslovak Chemical Communications *(Czechoslovakia)*
Comit. Nazl. Energia Nucl., Notiziario
Comitato Nazionale per l'Energia Nucleare, Notiziario *(Italy)*
Commun. Electron.
Communication and Electronics *(U. S.)*
Compt. Rend.
Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences *(France)*
Compt. Rend. Soc. Biol.
Comptes Rendus des Seances de la Societe de Biologie et de ses Filiales *(France)*
Compt. Rend. Soc. Franc. Gynecol.
Comptes Rendus de la Societe Francaise de Gynecologie *(France)*
Contemp. Phys.
Contemporary Physics *(England)*
Contrib. Cient., Univ. Buenos Aires, Fac. Cienc. Exact. Nat., Ser. Fis.
Contribuciones Cientificas, Universidad de Buenos Aires, Faculdad de Ciencias Exactas y Naturales, Serie Fisica *(Argentina)*
Corrosion
Corrosion *(U. S.)*
Corrosion Anti-Corrosion
Corrosion et Anti-Corrosion *(France)*
Croat. Chem. Acta
Croatica Chemica Acta *(Yugoslavia)*
Crop Sci.
Crop Science *(U. S.)*
Cryogenics
Cryogenics *(England)*
Current Sci. (India)
Current Science *(India)*
Czech. J. Phys.
Czechoslovak Journal of Physics *(Czechoslovakia)*
Danish Med. Bull.
Danish Medical Bulletin *(Denmark)*
Denki Shikensho Iho
Denki Shikensho Iho (Bulletin of the Electrotechnical Laboratory (Tokyo)) *(Japan)*
Dermatologica
Dermatologica *(Switzerland)*
Deut. Z. Verdauungs- Stoffwechselkrankh.
Deutsche Zeitschrift fuer Verdauungs-und Stoffwechselkrankheiten *(Germany)*
Develop. Biol.
Developmental Biology *(U. S.)*
Dissertation Abstr.
Dissertation Abstracts *(U. S.)*
Dokl. Akad. Nauk Azerb. SSR
Doklady Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S. S. R.)*
Dokl. Akad. Nauk SSSR
Doklady Akademii Nauk SSSR† *(U.S.S.R.)*
Dopovidi Akad. Nauk Ukr. RSR
Dopovidi Akademii Nauk Ukrains'koi RSR *(Ukrainian S.S.R.)*
Econ. Geol.
Economic Geology and the Bulletin of the Society of Economic Geologists *(U. S.)*
Electronics
Electronics *(U. S.)*
Elektrizitaetswirtschaft
Elektrizitaetswirtschaft *(Germany)*
Endeavour
Endeavour *(England)*
Endocrinology
Endocrinology *(U. S.)*
Energia Atomtech.
Energia es Atomtechnika *(Hungary)*
Energia Nucl. (Madrid)
Energia Nuclear (Madrid) *(Spain)*
Energia Nucl. (Milan)
Energia Nucleare (Milan) *(Italy)*
Energie Nucl.
Energie Nucleaire *(France)*
Ergeb. Allgem. Pathol. Pathol. Anat.
Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie *(Germany)*
Europa Nucl.
Europa Nucleare *(Italy)*
Experientia
Experientia *(Switzerland)*
Exptl. Cell Res.
Experimental Cell Research *(U. S.)*
Exptl. Mol. Pathol.
Experimental and Molecular Pathology *(U. S.)*
Exptl. Tech. Physik
Experimentelle Technik der Physik *(Germany)*

Federation Proc.
Federation Proceedings *(U. S.)*
Federation Proc., Transl. Suppl.
Federation Proceedings, Translation Supplement *(U. S.)*
Fiz. Metal. i Metalloved.
Fizika Metallov i Metallovedeniya, Akademiya Nauk SSSR, Ural'skii Filial† *(U.S.S.R.)*
Folia Biol. (Prague)
Folia Biologica (Prague) *(Czechoslovakia)*
Folia Clin. Intern.
Folia Clinica Internacional *(Spain)*
Folia Haematol. (Frankfurt)
Folia Haematologica (Frankfurt) *(Germany)*
Food Irradiation
Food Irradiation *(France)*
Fortschr. Gebiete Roentgenstrahlen Nuklearmed.
Fortschritte auf dem Gebiete der Roentgenstrahlen und der Nuklearmedizin, Diagnostik, Physik, Biologie, Therapie *(Germany)*
Fortschr. Physik
Fortschritte der Physik *(Germany)*
Frontier
Frontier, The *(U. S.)*
Gac. Ortoped. Traumatol.
Gaceta Ortopedia y Traumatologia *(Mexico)*
Gann
Gann *(Japan)*
Geburtsh Frauenheilk.
Geburtshilfe und Frauenheilkunde *(Germany)*
G.E.C.J. Sci. Tech.
G. E. C. Journal of Science and Technology *(England)*
G.E.N. (Caracas)
G.E.N. (Caracas) *(Venezuela)*
Gen. Comp. Endocrinol.
General and Comparative Endocrinology *(U. S.)*
Genetics
Genetics *(U. S.)*
Genet. Res.
Genetical Research *(England)*
Genshiryoku Hatsuden
Genshiryoku Hatsuden (Nuclear Power) *(Japan)*
Geochim. Cosmochim. Acta
Geochimica et Cosmochimica Acta *(England)*
Geokhimiya
Geokhimiya† *(U.S.S.R.)*
Gerontol. Clin.
Gerontologia Clinica *(Switzerland)*
Gerontologia
Gerontologia *(Switzerland)*
Ginecol. Obstet. Mex.
Ginecologia y Obstetricia de Mexico *(Mexico)*
Giorn. Gerontol.
Giornale di Gerontologia *(Italy)*
Giorn. Ital. Chemioterapia
Giornale Italiano di Chemioterapia *(Italy)*
Giorn. Microbiol.
Gironale di Microbiologia *(Italy)*
Glasnik Mat.-Fiz. Astron., Ser. II
Glasnik Matematicko-Fizicki i Astronomski, Serija II *(Yugoslavia)*
Guy's Hosp. Rept.
Guy's Hospital Reports *(England)*
Health Phys.
Health Physics *(U. S.-England)*
Helv. Chim. Acta
Helvetica Chimica Acta *(Switzerland)*
Helv. Paediat. Acta
Helvetica Paediatrica Acta *(Switzerland)*
Helv. Phys. Acta
Helvetica Physica Acta *(Switzerland)*
Heredity
Heredity *(England)*
Hindustan Antibiot. Bull.
Hindustan Antibiotics Bulletin *(India)*
Hiroshima J. Med. Sci.
Hiroshima Journal of Medical Sciences *(Japan)*
Ho Tsu K'o Hsueh
Ho Tsu K'o Hsueh (Nuclear Science) *(China)*
I.C.R.S. Med. Rept.
I.C.R.S. (Institute of Contemporary Russian Studies) Medical Reports *(U. S.)*
Idengaku Zasshi
Idengaku Zasshi (Japanese Journal of Genetics) *(Japan)*
IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci.
IEEE (Institute of Electrical and Electronics Engineers), Transactions on Nuclear Science (formerly IRE (Institute of Radio Engineers), Transactions on Nuclear Science) *(U. S.)*
Immunology
Immunology *(England)*
Ind. At.
Industries Atomiques *(France)*
Ind. Chim. Belge
Industrie Chimique Belge *(Belgium)*
Ind. Eng. Chem.
Industrial and Engineering Chemistry *(U. S.)*
Ind. Eng. Chem., Fundamentals
Industrial & Engineering Chemistry, Fundamentals *(U. S.)*
Ind. Eng. Chem., Process Design Develop.
Industrial & Engineering Chemistry, Process Design and Development *(U. S.)*
Ind. Eng. Chem., Prod. Res. Develop.
Industrial & Engineering Chemistry, Product Research and Development *(U. S.)*
Indian J. Chem.
Indian Journal of Chemistry *(India)*
Indian J. Child Health
Indian Journal of Child Health, The *(India)*
Indian J. Med. Sci.
Indian Journal of Medical Sciences *(India)*
Indian J. Phys.
Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science *(India)*
Indian J. Pure Appl. Phys.
Indian Journal of Pure & Applied Physics *(India)*
Indian J. Radiol.
Indian Journal of Radiology *(India)*
Ind. Rev. Africa. Suppl. At. Energy
Industrial Review of Africa. Supplement. Atomics and Energy *(Union of S. Africa)*
Inorg. Chem.
Inorganic Chemistry *(U. S.)*
Instr. Pract.
Instrument Practice *(England)*
Intern. Arch. Allergy Appl. Immunol.
International Archives of Allergy and Applied Immunology *(Switzerland)*
Intern. At. Energy Agency Bull.
International Atomic Energy Agency Bulletin *(Austria)*
Intern. Chem. Eng.
International Chemical Engineering *(U. S.)*
Intern. J. Air Water Pollution
International Journal of Air & Water Pollution (formerly International Journal of Air Pollution) *(England)*
Intern. J. Appl. Radiation Isotopes
International Journal of Applied Radiation and Isotopes *(England)*
Intern. J. Fertility
International Journal of Fertility *(U. S.)*
Intern. J. Heat Mass Transfer
International Journal of Heat and Mass Transfer *(England)*
Intern. J. Radiation Biol.
International Journal of Radiation Biology and related studies in Physics, Chemistry and Medicine *(England)*

Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR
Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk Belorusskoi SSR *(U.S.S.R.)*

Istanbul Univ., Fen Fak. Mecmuasi, Seri C
Istanbul Universitesi Fen Fakultesi Mecmuasi: Seri C: Astronomi-Fizik-Kimya *(Turkey)*

Ital. J. Biochem.
Italian Journal of Biochemistry (English edition of Giornale de biochimica) *(Italy)*

Izmeritel. Tekhn.
Izmeritel'naya Tekhnika† *(U.S.S.R.)*

Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*

Izv. Akad. Nauk Azerb. SSR, Ser. Fiz. Mat. i Tekhn. Nauk
Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko-Matematicheskikh i Tekhnicheskikh Nauk (formerly Izvestiya Akademii Nauk Azerbaidzhanskoi SSR, Seriya Fiziko Tekhnicheskikh i Khimicheskikh Nauk) *(Azerbaidzhan S.S.R.)*

Izv. Akad. Nauk Est. SSR, Ser. Biol.
Izvestiya Akademii Nauk Estonskoi SSR, Seriya Biologicheskaya *(Estonian S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Khim. Nauk
Izvestiya Akademii Nauk SSSR, Otdelenie Khimicheskikh Nauk† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Energ. i Transp.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Transport (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Energetika i Avtomatika) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Mekhan. i Mashinostr.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie (formerly included with two other parts in Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Gorn. Delo
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Gornoe Delo (formerly Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Metallurgiya i Toplivo) *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Biol.
Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Fiz.
Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya† *(U.S.S.R.)*

Izv. Akad. Nauk SSSR, Ser. Geofiz.
Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya† *(U.S.S.R.)*

Izv. Sibirsk. Otd. Akad. Nauk SSSR
Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Fiz.
Izvestiya Vysshikh Uchebnykh Zavedenii, Fizika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Mat.
Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met.
Izvestiya Vysshikh Uchebnykh Zavednii, Tsvetnaya Metallurgiya *(U.S.S.R.)*

Jaderna Energie
Jaderna Energie *(Czechoslovakia)*

J. Air Pollution Control Assoc.
Journal of the Air Pollution Control Association *(U. S.)*

J. Am. Ceram. Soc.
Journal of the American Ceramic Society *(U. S.)*

J. Am. Chem. Soc.
Journal of the American Chemical Society *(U. S.)*

J. Am. Concrete Inst.
Journal of the American Concrete Institute *(U. S.)*

J. Am. Med. Assoc.
Journal of the American Medical Association, The *(U. S.)*

J. Am. Water Works Assoc.
Journal of the American Water Works Association *(U. S.)*

Japan Analyst
Japan Analyst
see *Bunseki Kagaku*

Japan. Circulation J. (English Ed.)
Japanese Circulation Journal (English Edition) *(Japan)*

Japan. Heart J.
Japanese Heart Journal *(Japan)*

Japan. J. Appl. Phys.
Japanese Journal of Applied Physics *(Japan)*

Japan. J. Exptl. Med.
Japanese Journal of Experimental Medicine *(Japan)*

Japan. J. Genetics
Japanese Journal of Genetics
see *Idengaku Zasshi*

J. Appl. Chem. (London)
Journal of Applied Chemistry (London) *(England)*

J. Appl. Mech.
Journal of Applied Mechanics, Transactions of the ASME, Series E *(U. S.)*

J. Appl. Phys.
Journal of Applied Physics *(U. S.)*

J. Appl. Polymer Sci.
Journal of Applied Polymer Science *(U. S.)*

J. Assoc. Offic. Agr. Chemists
Journal of the Association of Official Agricultural Chemists *(U. S.)*

J. At. Energ. Soc. Japan
Journal of the Atomic Energy Society of Japan
see *Nippon Genshiryoku Gakkaishi*

J. Atmospheric Sci.
Journal of the Atmospheric Sciences (formerly the Journal of Meteorology) *(U. S.)*

J. Australian Inst. Metals
Journal of the Australian Institute of Metals *(Australia)*

J. Bacteriol.
Journal of Bacteriology *(U. S.)*

J. Basic Eng.
Journal of Basic Engineering, Transactions of the ASME, Series D *(U. S.)*

J. Belge Radiol.
Journal Belge de Radiologie *(Belgium)*

J. Biol. Chem.
Journal of Biological Chemistry, The *(U. S.)*

J. Brasil. Neurol.
Journal Brasileiro de Neurologia *(Brazil)*

J. Brasil. Psiquiat.
Journal Brasileiro de Psiquiatria *(Brazil)*

J. Brit. Interplanet. Soc.
Journal of the British Interplanetary Society *(England)*

J. Brit. Nucl. Energy Soc.
Journal of the British Nuclear Energy Society, The (formerly Journal of the British Nuclear Energy Conference) *(England)*

J. Cellular Comp. Physiol.
Journal of Cellular and Comparative Physiology *(U. S.)*

J. Ceram. Assoc. Japan
Journal of the Ceramic Association of Japan
see *Yogyo Kyokai Shi*

J. Chem. Eng. Data
Journal of Chemical and Engineering Data *(U. S.)*

J. Chem. Phys.
Journal of Chemical Physics, The *(U. S.)*

J. Chem. Soc.
Journal of the Chemical Society (London) *(England)*

J. Chem. Soc. Japan, Pure Chem. Sect.
Journal of the Chemistry Society of Japan, Pure Chemistry Section
see *Nippon Kagaku Zasshi*

J. Chim. Phys.
*Journal de Chimie Physique et de Physicochimie Biologique *(France)*

J. Chromatog.
Journal of Chromatography *(Netherlands)*
J. Clin. Endocrinol. Metab.
Journal of Clinical Endocrinology and Metabolism, The *(U. S.)*
J. Clin. Invest.
Journal of Clinical Investigation, The *(U. S.)*
J. Colloid Sci.
Journal of Colloid Science *(U. S.)*
J. Egypt. Med. Assoc.
Journal of the Egyptian Medical Association, The *(Egypt)*
J. Electroanal. Chem.
Journal of Electroanalytical Chemistry *(Netherlands)*
J. Electrochem. Soc.
Journal of the Electrochemical Society *(U. S.)*
J. Electron. Control
Journal of Electronics and Control *(U. S.)*
J. Embryol. Exptl. Morphol.
Journal of Embryology and Experimental Morphology *(England)*
J. Eng. Ind.
Journal of Engineering for Industry, Transactions of the ASME, Series B *(U. S.)*
J. Eng. Power
Journal of Engineering for Power, Transactions of the ASME, Series A *(U. S.)*
J. Exptl. Med.
Journal of Experimental Medicine *(U. S.)*
J. Fluid Mech.
Journal of Fluid Mechanics *(U. S.)*
J. Franklin Inst.
Journal of the Franklin Institute *(U. S.)*
J. Genet.
Journal of Genetics *(U. S.)*
J. Geomagnet. Geoelec.
Journal of Geomagnetism and Geoelectricity *(Japan)*
J. Geophys. Res.
Journal of Geophysical Research *(U. S.)*
J. Gerontol.
Journal of Gerontology *(U. S.)*
J. Heat Transfer
Journal of Heat Transfer, Transactions of the ASME, Series C *(U. S.)*
J. Immunol.
Journal of Immunology, The *(U. S.)*
J. Indian Chem. Soc.
Journal of the Indian Chemical Society *(India)*
J. Indian Inst. Sci.
Journal of the Indian Institute of Science *(India)*
J. Inorg. Nucl. Chem.
Journal of Inorganic & Nuclear Chemistry *(England)*
J. Inst. Metals
Journal of the Institute of Metals with Bulletin and Metallurgical Abstracts *(England)*
J. Iron Steel Inst. (London)
Journal of the Iron and Steel Institute (London) *(England)*
J. Japan Inst. Metals (Sendai)
Journal of the Japan Institute of Metals (Sendai)
see ***Nippon Kinzoku Gakkaishi***
J. Joint Panel Nucl. Marine Propulsion
Journal of the Joint Panel on Nuclear Marine Propulsion *(England)*
J. Lab. Clin. Med.
Journal of Laboratory and Clinical Medicine, The *(U. S.)*
J. Less-Common Metals
Journal of the Less-Common Metals *(Netherlands)*
J. Math. Anal. Appl.
Journal of Mathematical Analysis and Applications *(U. S.)*
J. Math. Phys. (N. Y.)
Journal of Mathematical Physics (New York) *(U. S.)*
J. Mecan.
Journal de Mecanique *(France)*
J. Metals
Journal of Metals *(U. S.)*

J. Microbiol., Epidemiol. Immunobiol. (USSR) (English Transl.)
Journal of Microbiology, Epidemiology and Immunobiology (USSR) (English Translation of Zhurnal Mikrobiologii, Epidemiologii i Immunobiologii) *(England)*
J. Mol. Biol.
Journal of Molecular Biology *(England)*
J. Mol. Spectry.
Journal of Molecular Spectroscopy *(U. S.)*
J. Natl. Cancer Inst.
Journal of the National Cancer Institute *(U. S.)*
J. Natl. Res. Council Thailand
Journal of the National Research Council of Thailand (contains Part I. Natural Science and Part II. Social Science, paged separately) *(Thailand)*
J. Nat. Sci. Math.
Journal of Natural Sciences and Mathematics *(Pakistan)*
J. Nucl. Energy: Pt. A & B
Journal of Nuclear Energy: Parts A & B. Reactor Science and Technology (formerly issued separately) *(England)*
J. Nucl. Energy: Pt. C
Journal of Nuclear Energy: Part C. Plasma Physics–Accelerators–Thermonuclear Research *(England)*
J. Nucl. Mater.
Journal of Nuclear Materials (Journal des Materiaux Nucleaires) *(Netherlands)*
J. Nucl. Med.
Journal of Nuclear Medicine *(U. S.)*
J. Opt. Soc. Am.
Journal of the Optical Society of America *(U. S.)*
J. Org. Chem.
Journal of Organic Chemistry, The *(U. S.)*
J. Phys. (Paris)
Journal de Physique (Paris) (formerly Le Journal de Physique et le Radium) *(France)*
J. Phys. Chem.
Journal of Physical Chemistry, The *(U. S.)*
J. Phys. Chem. Solids
Journal of Physics and Chemistry of Solids (formerly Physics and Chemistry of Solids, The) *(U. S.)*
J. Phys. Soc. Japan
Journal of the Physical Society of Japan
J. Polymer Sci. Pt. A
Journal of Polymer Science. Part A: General Papers *(U. S.)*
J. Polymer Sci. Pt. B
Journal of Polymer Science. Part B: Polymer Letters *(U. S.)*
J. Polymer Sci. Pt. C
Journal of Polymer Science. Part C: Polymer Symposia *(U. S.)*
J. Proc. Roy. Soc. N. S. Wales
Journal and Proceedings of the Royal Society of New South Wales *(Australia)*
J. Quant. Spectry. Radiative Transfer
Journal of Quantitative Spectroscopy & Radiative Transfer *(England)*
J. Radiation Res. (Japan)
Journal of Radiation Research *(Japan)*
J. Radiol., Electrol. Med. Nucl.
Journal de Radiologie, d'Electrologie, et de Medicine Nucleaire *(France)*
J. Res. Inst. Catalysis, Hokkaido Univ.
Journal of the Research Institute for Catalysis, Hokkaido University *(Japan)*
J. Res. Natl. Bur. Std.
Journal of Research of the National Bureau of Standards (now divided into the following sections: A. Physics and Chemistry; B. Mathematics and Mathematical Physics; C. Engineering and Instrumentation; and D. Radio Propagation) *(U. S.)*
J. S. African Inst. Mining Met.
Journal of the South African Institute of Mining and Metallurgy, The *(Union of S. Africa)*
J. Sci. Food Agr.
Journal of the Science of Food and Agriculture *(England)*

J. Sci. Hiroshima Univ. Ser. A-II
Journal of Science of the Hiroshima University. Series A-II *(Japan)*

J. Sci. Instr.
Journal of Scientific Instruments *(England)*

J. Theoret. Biol.
Journal of Theoretical Biology *(England)*

J. Ultrastruct. Res.
Journal of Ultrastructure Research *(U. S.)*

Kernenergie
Kernenergie *(Germany)*

Kerntechnik
Kerntechnik, Isotopentechnik und -Chemie *(Germany)*

Kgl. Danske Videnskab. Selskab, Mat.-Fys. Medd.
Kongelige Danske Videnskabernes Selskab, Det, Matematisk-fysiske Meddelelser *(Denmark)*

Kgl. Norske Videnskab. Selskabs, Forh.
Kongelige Norske Videnskabers Selskabs, Det, Forhandlinger *(Norway)*

Kinetika i Kataliz
Kinetika i Kataliz† *(U.S.S.R.)*

Klin. Wochschr.
Klinische Wochenschrift *(Germany)*

Kobunshi Kagaku
Kobunshi Kagaku (Chemistry of High Polymers) *(Japan)*

Kolloidn. Zh.
Kolloidnyi Zhurnal† *(U.S.S.R.)*

Krebsarzt
Krebsarzt, Der *(Austria)*

Kwayon Hwibo
Kwayon Hwibo (Bulletin of the Scientific Research Institute (Seoul, Korea)) *(Korea)*

Lab. Invest.
Laboratory Investigation *(U. S.)*

Lille Med.
Lille Medical *(France)*

Magy. Tud. Akad. At. Kut. Int. (Debrecen). Kozlemen.
Magyar Tudomanyos Akademia Atommag Kutato Intezete (Debrecen). Kozlemenyek *(Hungary)*

Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen.
Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezetenek Kozlemenyei *(Hungary)*

Makromol. Chem.
Makromolekulare Chemie *(Switzerland)*

Mal. Cardiovascolari
Malattie Cardiovascolari *(Italy)*

Mater. Design Eng.
Materials in Design Engineering (formerly Materials & Methods) *(U. S.)*

Mat. Fyz. Casopis
Matematicko-Fysikalny Casopis *(Czechoslovakia)*

Med. Exptl.
Medicina Experimentalis *(Switzerland)*

Medicamundi
Medicamundi *(Netherlands)*

Medicina (Mex.)
Medicina *(Mexico)*

Med. J. Malaya
Medical Journal of Malaya, The *(Malaya)*

Med. Radiol.
Meditsinskaya Radiologiya† *(U.S.S.R.)*

Mem. Acad. Roy. Med. Belg.
Memoires de l'Academie Royale de Medecine de Belgique *(Belgium)*

Mem. Fac. Sci., Kyushu Univ. Ser. B
Memoirs of the Faculty of Science, Kyushu University. Series B *(Japan)*

Mem. Sci. Rev. Met.
Memoires Scientifiques de la Revue de Metallurgie, Les (formerly a part of Revue de Metallurgie) *(France)*

Mem. Soc. Roy. Sci. Liege, Collection in 4°
Memoires de la Societe Royale des Sciences de Liege, Collection in 4° *(Belgium)*

Mem. Soc. Roy. Sci. Liege, Collection in 8°
Memoires de la Societe Royale des Sciences de Liege, Collection in 8° *(Belgium)*

Metall
Metall *(Germany)*

Metalloved. i Term. Obrabotka Metal.
Metallovedenie i Termicheskaya Obrabotka Metallov† (formerly Metallovedenie i Obrabotka Metallov) *(U.S.S.R.)*

Metallurgia
Metallurgia *(England)*

Metal Progr.
Metal Progress *(U. S.)*

Metal Treat. Drop Forging
Metal Treatment and Drop Forging *(England)*

Met. Ital.
Metallurgia Italiana, La *(Italy)*

Met. Rev.
Metallurgical Reviews *(England)*

Microchem. J.
Microchemical Journal *(U. S.)*

Minerva Nucl.
Minerva Nucleare *(Italy)*

Mol. Phys.
Molecular Physics *(U. S.)*

Monthly Notices Roy. Astron. Soc.
Monthly Notices of the Royal Astronomical Society *(England)*

Montpellier Med.
Montpellier Medical *(France)*

Natl. Inst. Animal Health Quart.
National Institute of Animal Health Quarterly (Tokyo) *(Japan)*

Nature
Nature (London) *(England)*

Naturwissenschaften
Naturwissenschaften, Die *(Germany)*

Neue Physik
Neue Physik *(Austria)*

Neue Tech.
Neue Technik *(Germany)*

Neurocirugia (Lima)
Neurocirugia (Lima) *(Peru)*

News-Bull. Intern. (Argonne Natl. Lab.)
News-Bulletin International (Argonne National Laboratory) (formerly News-Bulletin (Argonne National Laboratory)) *(U. S.)*

New Zealand J. Sci.
New Zealand Journal of Science *(New Zealand)*

Nippon Genshiryoku Gakkaishi
Nippon Genshiryoku Gakkaishi (Journal of the Atomic Energy Society of Japan) *(Japan)*

Nippon Kagaku Zasshi
Nippon Kagaku Zasshi (Journal of the Chemistry Society of Japan, Pure Chemistry Section) *(Japan)*

Nippon Kinzoku Gakkaishi
Nippon Kinzoku Gakkaishi (Journal of the Japan Institute of Metals (Sendai)) *(Japan)*

Nondestructive Testing
Nondestructive Testing (Journal of the Society of Nondestructive Testing) *(U. S.)*

Nucl. Energy
Nuclear Energy (formerly Nuclear Energy Engineer) *(England)*

Nucl. Eng.
Nuclear Engineering incorporating Nuclear Power *(England)*

Nucl. Eng. Abstr.
Nuclear Engineering Abstracts *(England)*

Nucleonics
Nucleonics *(U. S.)*

Nucleus (Paris)
Nucleus. La Revue Scientifique a l'Age Atomique (Paris) *(France)*

Nucl. Fusion
Nuclear Fusion (Journal of Plasma Physics and Thermonuclear Fusion *(Austria)*

Nucl. Instr. Methods
Nuclear Instruments & Methods (formerly Nuclear Instruments) *(Netherlands)*

Nucl.-Med.
Nuclear-Medizin *(Germany)*

Nucl. News
Nuclear News *(U. S.)*

Nucl. Phys.
Nuclear Physics *(Netherlands)*

Nucl. Sci. (Taiwan)
Nuclear Science (Taiwan) *(China)*
see Ho Tsu K'o Hsueh

Nucl. Sci. Abstr. Japan
Nuclear Science Abstracts of Japan *(Japan)*

Nucl. Sci. Eng.
Nuclear Science and Engineering *(U. S.)*

Nukleonik
Nukleonik *(Germany)*

Nukleonika
Nukleonika *(Poland)*

Nuntius Radiol.
Nuntius Radiologicus *(Italy)*

Nuovo Cimento
Nuovo Cimento (Including all supplements) *(Italy)*

Oncologia
Oncologia *(Switzerland)*

Ophthalmol. Ibero-Am.
Ophthalmologia Ibero-Americana *(Brazil)*

Opt. Spectry. (USSR) (English Transl.)
Optics and Spectroscopy (USSR) (English Translation of Optika i Spektroskopiya) *(U. S.)*

Pacific Sci.
Pacific Science *(U. S.)*

Pakistan J. Sci. Ind. Res.
Pakistan Journal of Scientific and Industrial Research *(Pakistan)*

Pathol. Biol. Semaine Hop.
Pathologie et Biologie, Archives de Biologie Medicale, Annales de la Recherche Medicale, La Semaine des Hopitaux *(France)*

Pathologica
Pathologica *(Italy)*

Pediat. Pratica
Pediatria Pratica *(Brazil)*

Pediatria (Santiago, Chile)
Pediatria (Santiago, Chile) *(Chile)*

Perspectives Biol. Med.
Perspectives in Biology and Medicine *(U. S.)*

Philips Tech. Rev.
Philips Technical Review *(Netherlands)*

Phil. Mag.
Philosophical Magazine, The *(England)*

Phot. Sci. Eng.
Photographic Science and Engineering *(U. S.)*

Phys. Chem. Solids
Physics and Chemistry of Solids, The *(U. S.)*

Phys. Fluids
Physics of Fluids, The *(U. S.)*

Physica
Physica *(Netherlands)*

Phys. Letters
Physics Letters *(Netherlands)*

Phys. Med. Biol.
Physics in Medicine and Biology *(England)*

Phys. Rev.
Physical Review, The *(U. S.)*

Phys. Rev. Letters
Physical Review Letters *(U. S.)*

Phys. Status Solidi
Physica Status Solidi *(Germany)*

Planetary Space Sci.
Planetary and Space Science *(England)*

Planseeber. Pulvermet.
Planseeberichte fuer Pulvermetallurgie Vereinigt mit Powder Metallurgy Bulletin *(Austria)*

Plant Physiol.
Plant Physiology *(U. S.)*

Plasma Phys.-Accelerators-Thermonucl. Res., J. Nucl. Energy: Pt. C
Plasma Physics-Accelerators-Thermonuclear Research, Journal of Nuclear Energy: Part C
see J. Nucl. Energy: Pt. C

Polski Przeglad Radiol. i Med. Nuklearnej
Polski Przeglad Radiologii i Medycyny Nuklearnej *(Poland)*

Poroshkovaya Met., Akad. Nauk Ukr. SSR
Poroshkovaya Metallurgiya, Akademiya Nauk Ukrainskoi SSR *(Ukrainian S.S.R.)*

Postepy Fiz.
Postepy Fizyki *(Poland)*

Powder Met.
Powder Metallurgy *(England)*

Prace Inst. Hutniczych
Prace Instytutow Hutniczych *(Poland)*

Prace Inst. Tech. Cieplnej
Prace Instytutu Techniki Cieplnej *(Poland)*

Pracovni Lekar.
Pracovni Lekarstvi *(Czechoslovakia)*

Presbyterian-St. Luke's Hosp. Med. Bull.
Presbyterian-St. Luke's Hospital Medical Bulletin *(U. S.)*

Pribory i Tekhn. Eksperim.
Pribory i Tekhnika Eksperimenta† *(U.S.S.R.)*

Prikl. Mat. i Mekhan.
Prikladnaya Matematika i Mekhanika† *(U.S.S.R.)*

Primena Radioaktiv. Izotopa i Jonizujucih Zracenja u Med.
Primena Radioaktivnih Izotopa i Jonizujucih Zracenja u Medicini *(Yugoslavia)*

Priroda
Priroda *(U.S.S.R.)*

Probl. Oncol. (USSR) (English Transl.)
Problems of Oncology (USSR) (English Translation of Voprosy Onkologii) *(England)*

Proc. Cambridge Phil. Soc.
Proceedings of the Cambridge Philosophical Society (England)

Proc. Chem. Soc.
Proceedings of the Chemical Society *(England)*

Proc. Indian Acad. Sci., Sect. A
Proceedings of the Indian Academy of Sciences, Section A *(India)*

Proc. Inst. Elec. Engrs. (London), Pt. B
Proceedings of the Institution of Electrical Engineers, The (London) (formerly Journal of the Institution of Electrical Engineers), Pt. B *(England)*

Proc. Math. Phys. Soc. (U.A.R.)
Proceedings of the Mathematical and Physical Society of (U. A. R.) *(Egypt)*

Proc. Natl. Acad. Sci. U. S.
Proceedings of the National Academy of Sciences of the United States of America *(U. S.)*

Proc. Natl. Inst. Sci. India. Pt. A
Proceedings of the National Institute of Sciences of India. Part A *(India)*

Proc. Phys. Seminar Trondheim
Proceedings of the Physics Seminar in Trondheim *(Norway)*

Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London), The *(England)*

Proc. Roy. Irish Acad., Sect. A
Proceedings of the Royal Irish Academy, Section A *(Ireland)*

Proc. Roy. Irish Acad., Sect. B
Proceedings of the Royal Irish Academy, Section B *(Ireland)*

Proc. Roy. Soc. (London), Ser. A
Proceedings of the Royal Society (London), Series A *(England)*

Proc. Roy. Soc. (London), Ser. B
Proceedings of the Royal Society (London), Series B *(England)*

Proc. Soc. Exptl. Biol. Med.
Proceedings of the Society for Experimental Biology and Medicine *(U. S.)*

Progr. Nucl. Phys.
Progress in Nuclear Physics *(U. S.)*

Progr. Theoret. Phys. (Kyoto)
Progress of Theoretical Physics (Kyoto) *(Japan)*

Protides Biol. Fluids, Proc. Colloq.
Protides of the Biological Fluids, Proceedings of the Colloquium *(Belgium)*

Przemysl Chem.
Przemysl Chemiczny *(Poland)*

Publ. Com. Nacl. Energia At. (Buenos Aires) Fis. Teorica
Publicaciones de la Comision Nacional de Energia Atomica (Buenos Aires) Fisica Teorica *(Argentina)*

Publ. Com. Nacl. Energia At. (Buenos Aires) Misc.
Publicaciones de la Comision Nacional de Energia Atomica (Buenos Aires) Miscelanea *(Argentina)*

Publ. Com. Nacl. Energia At. (Buenos Aires) Ser. Fis.
Publicaciones de la Comision Nacional de Energia Atomica (Buenos Aires) Serie Fisica *(Argentina)*

Publ. Com. Nacl. Energia At. (Buenos Aires) Ser. Mat.
Publicaciones de la Comision Nacional de Energia Atomica (Buenos Aires) Serie Matematica *(Argentina)*

Publ. Com. Nacl. Energia At. (Buenos Aires) Ser. Quim.
Publicaciones de la Comision Nacional de Energia Atomica (Buenos Aires) Serie Quimica *(Argentina)*

Public Health Eng. Abstr.
Public Health Engineering Abstracts *(U. S.)*

Public Health Rept. (U. S.)
Public Health Reports *(U. S.)*

Pure Appl. Chem.
Pure and Applied Chemistry (The Official Journal of the International Union of Pure and Applied Chemistry) *(U. S.)*

Quart. Appl. Math.
Quarterly of Applied Mathematics *(U. S.)*

Quart. J. Roy. Astron. Soc.
Quarterly Journal of the Royal Astronomical Society, The *(England)*

Quart. Rev. Biol.
Quarterly Review of Biology, The *(U. S.)*

Radiation Botany
Radiation Botany *(England)*

Radiation Res.
Radiation Research *(U. S.)*

Radiobiol. Latina
Radiobiologica Latina *(Italy)*

Radiobiologiya
Radiobiologiya† *(U.S.S.R.)*

Radiobiol. Radioterap. Fis. Med.
Radiobiologia, Radioterapia e Fisica Medica (formerly Radioterapia, Radiobiologia e Fisica Medica) *(Italy)*

Radiocarbon
Radiocarbon *(U. S.)*

Radioisotopes (Tokyo)
Radioisotopes (Tokyo) *(Japan)*

Radiokhimiya
Radiokhimiya† *(U.S.S.R.)*

Radiol. Clin.
Radiologia Clinica *(Switzerland)*

Radiol. Med.
Radiologia Medica, La *(Italy)*

Radiology
Radiology *(U. S.)*

Radiotekhn. i Elektron.
Radiotekhnika i Elektronika† *(U.S.S.R.)*

R C A Rev.
R C A Review *(U. S.)*

Reactor Sci. Technol., J. Nucl. Energy: Pt. A & B
Reactor Science and Technology, Journal of Nuclear Energy: Parts A & B
see J. Nucl. Energy: Pt. A & B

Rec. Trav. Chim.
Recueil des Travaux Chimiques des Pays-Bas *(Netherlands)*

Rept. Govt. Chem. Ind. Res. Inst., Tokyo
Reports of the Government Chemical Industrial Research Institute, Tokyo
see Tokyo Kogyo Shikensho Hokoku

Res./Develop.
Research/Development (formerly Industrial Laboratories) *(U. S.)*

Res. Reactor J.
Research Reactor Journal *(U. S.)*

Reumatismo
Reumatismo *(Italy)*

Rev. Arg. Alergia
Revista Argentina de Alergia *(Argentina)*

Rev. Arg. Anestesiol.
Revista Argentina de Anestesiologia *(Argentina)*

Rev. Arg. Tuberc. Enfermedades Pulmonares
Revista Argentina de Tuberculosis y Enfermedades Pulmonares *(Argentina)*

Rev. Asoc. Med. Rio Grande do Sul
Revista da Asociacao Medica do Rio Grande do Sul *(Brazil)*

Rev. Belge Pathol. Med. Exptl.
Revue Belge de Pathologie et de Medecine Experimentale *(Belgium)*

Rev. Brasil. Gastroenterol.
Revista Brasileira de Gastroenterologia *(Brazil)*

Rev. Can. Biol.
Revue Canadienne de Biologie *(Canada)*

Rev. Chilena Pediat.
Revista Chilena de Pediatria *(Chile)*

Rev. Col. Med. Guatemala
Reviste del Colegio Medico de Guatemala *(Guatemala)*

Rev. Cubana Cardiol.
Revista Cubana de Cardiologia *(Cuba)*

Rev. Electrotech. Energet., Acad. Rep. Populaire Roumaine
Revue d'Electrotechnique et d'Energetique, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Espan. Fisiol.
Revista Espanola de Fisiologia *(Spain)*

Rev. Espan. Oto-neuro-oftalmol. Neurocir.
Revista Espanola de Oto-neuro-oftalmologia y Neurocirugia *(Spain)*

Rev. Espan. Reumat. Enfermedades Osteoarticulares
Revista Espanola de Reumatismo y Enfermedades Osteo-articulares *(Spain)*

Rev. Espan. Tuberc.
Revista Espanola de Tuberculosis y Archivos Nacionales de Enfermedades del Torax *(Spain)*

Rev. Ginecol. Obstet. (Rio de Janeiro)
Revista de Ginecologia e d'Obstetricia (Rio de Janeiro) *(Brazil)*

Rev. Goiana Med.
Revista Goiana de Medicina *(Brazil)*

Rev. Hosp. Clin. Fac. Med. Univ. Sao Paulo
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Rev. Hosp. Nino (Lima)
Revista del Hospital del Nino (Lima) *(Peru)*

Rev. Hosp. San Juan de Dios (Bogota)
Revista del Hospital de San Juan de Dios (Bogota) *(Colombia)*

Rev. Iberica Endocrinol.
Revista Iberica de Endocrinologia *(Spain)*

Rev. Immunol.
Revue d'Immunologie et de Therapie Antimicrobienne *(France)*

Rev. Inst. Med. Trop. Sao Paulo
Revista do Instituto de Medicina Tropical de Sao Paulo *(Brazil)*

Rev. Invest. Clin. Organo Hosp. Enfermedades Nutr. Mex.
Revista de Investigacion Clinica, Organo del Hospital de Enfermedades de la Nutricion, Mexico *(Mexico)*

Rev. Latinoam. Anat. Patol.
Revista Latinoamericana de Anatomia Patologica *(Venezuela)*

Rev. Latino-Am. Cir. Plastica
Revista Latinoamericana de Cirugia Plastica *(Mexico)*

Rev. Latinoam. Microbiol.
Revista Latinoamericana de Microbiologia *(Mexico)*

Rev. Leprol. (Fontilles)
Revista de Leprologia (Fontilles) *(Spain)*

Rev. M.B.L.E.
Revue de Manufacture Belge de Lampes et de Materiel *(Belgium)*

Rev. Med. Aeronaut. (Rio de Janeiro)
Revista Medica da Aeronautica (Rio de Janeiro) *(Brazil)*

Rev. Med. Cordoba
Revista Medica de Cordoba *(Argentina)*

Rev. Med. Hosp. Colonia (Mex.)
Revista Medica del Hospital Colonia *(Mexico)*

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Revista Medica del Hospital Espanol *(Mexico)*

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Revista Medica del Hospital Obrero (Lima) *(Peru)*

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Revista de Medicina do Rio Grande do Sul *(Brazil)*

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Revista Medica de Valparaiso *(Chile)*

Rev. Met. (Paris)
Revue de Metallurgie (Paris) *(France)*

Rev. Metal Lit.
Review of Metal Literature *(U. S.)*

Rev. Mex. Cienc. Med. Biol.
Revista Mexicana de Ciencias Medicas y Biologicas *(Mexico)*

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Revista Mexicana de Cirugia, Ginecologia y Cancer *(Mexico)*

Rev. Mex. Fis.
Revista Mexicana de Fisica *(Mexico)*

Rev. Mex. Tuberc. Aparato Respirat.
Revista Mexicana de Tuberculosis y Aparato Respiratorio *(Mexico)*

Rev. Mod. Phys.
Reviews of Modern Physics *(U. S.)*

Rev. Neurol. Buenos Aires
Revista Neurologica de Buenos Aires *(Argentina)*

Rev. Obstet. Ginecol. (Caracas)
Revista de Obstetricia y Ginecologia (Caracas) *(Venezuela)*

Rev. Ortoped. Traumatol. Latinoam.
Revista de Ortopedia y Traumatologia Latinoamericana *(Argentina)*

Rev. Otorrinolaringol. (Santiago, Chile)
Revista de Otorrinolaringologia (Santiago, Chile) *(Chile)*

Rev. Phys., Acad. Rep. Populaire Roumaine
Revue de Physique, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Psiquiat. (Santiago, Chile)
Revista de Psiquiatria (Santiago, Chile) *(Chile)*

Rev. Psiquiat. Peruana
Revista Psiquiatrica Peruana *(Peru)*

Rev. Rhumat.
Revue du Rhumatisme et des Maladies Osteo-Articulaires *(France)*

Rev. Roumaine Met., Acad. Rep. Populaire Roumaine
Revue Roumaine de Metallurgie, Academie de la Republique Populaire Roumaine *(Romania)*

Rev. Sci. Instr.
Review of Scientific Instruments, The *(U. S.)*

Rev. Soc. Med.-Quir. Zulia
Revista de la Sociedad Medico-Quirurgica del Zulia *(Venezuela)*

Rev. Union Mat. Arg. Asoc. Fis. Arg.
Revista de la Union Matematica Argentina y de la Asociacion Fisica Argentina *(Argentina)*

Rev. Urol. (Caracas)
Revista de Urologia (Caracas) *(Venezuela)*

Rev. Urol. (Mex.)
Revista de Urologia *(Mexico)*

Rheumatism
Rheumatism *(England)*

Ric. Sci., Rend.
Ricerca Scientifica, La. Serie Seconda, Parte II, Rendiconti *(Italy)*

Riv. Biol.
Rivista di Biologia (Pubblicata a Cura dell'Istituto di Biologia Generale dell'Universita di Perugia) *(Italy)*

Riv. Clin. Pediat.
Rivista di Clinica Pediatrica *(Italy)*

Riv. Ist. Sieroterap. Ital.
Rivista dell'Istituto Sieroterapico Italiano *(Italy)*

Roczniki Chem.
Roczniki Chemii *(Poland)*

Roentgen Bl.
Roentgen Blaetter *(Germany)*

Rumanian Med. Rev.
Rumanian Medical Review *(Romania)*

Santo Tomas J. Med.
Santo Tomas Journal of Medicine *(Philippines)*

Sb. Nauchn. Rabot Inst. Metallofiz., Akad. Nauk Ukr. SSR
Sbornik Nauchnykh Rabot Instituta Metallofiziki, Akademiya Nauk Ukrainskoi SSR *(Ukrainian SSR)*

Sci. Am.
Scientific American *(U. S.)*

Science
Science *(U. S.)*

Sci. Papers Coll. Gen. Educ., Univ. Tokyo
Scientific Papers of the College of General Education, University of Tokyo *(Japan)*

Sci. Papers Inst. Phys. Chem. Res. (Tokyo)
Scientific Papers of the Institute of Physical and Chemical Research (Tokyo) (formerly Journal of the Scientific Research Institute (Tokyo)) *(Japan)*

Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ.
Scientific Reports of the Research Institute for Theoretical Physics, Hiroshima University *(Japan)*

Sci. Rept. Res. Inst., Tohoku Univ., Ser. A
Scientific Reports of the Research Institutes, The, Tohoku University, Series A *(Japan)*

Sci. Sinica (Peking)
Scientia Sinica (Peking) *(China)*

SIAM (Soc. Ind. Appl. Math.) Rev.
SIAM (Society for Industrial and Applied Mathematics) Review *(U. S.)*

Sibirsk. Mat. Zh.
Sibirskii Matematicheskii Zhurnal *(U.S.S.R.)*

SNTL Tech. Dig.
SNTL (Statne Nakladatelstvo Technickej Literatury) Technical Digest *(Czechoslovakia)*

Soc. Sci. Fennica, Commentationes Phys.-Math.
Societas Scientiarum Fennica, Commentationes Physico-Mathematicae *(Finland)*

Soil Sci.
Soil Science *(U. S.)*

Soil Sci. Soc. Am., Proc.
Soil Science Society of America, Proceedings *(U. S.)*

Soviet Astron. AJ (English Transl.)
Soviet Astronomy–AJ (English Translation of Astronomicheskii Zhurnal) *(U. S.)*

Soviet Phys.–Cryst. (English Transl.)
Soviet Physics–Crystallography (English Translation of Kristallografiya) *(U. S.)*

Soviet Phys.-Solid State (English Transl.)
Soviet Physics–Solid State (English translation of Fizika Tverdogo Tela) *(U. S.)*

Space Sci. Rev.
Space Science Reviews *(Netherlands)*

Spectrochim. Acta
Spectrochimica Acta *(England)*

Strahlentherapie
Strahlentherapie *(Germany)*

Sulzer Tech. Rev. (Switz.)
Sulzer Technical Review *(Switzerland)*

Suomen Kemistilehti, A
Suomen Kemistilehti, Section A *(Finland)*

Suomen Kemistilehti, B
Suomen Kemistilehti, Section B *(Finland)*

Svensk Kem. Tidskr.
Svensk Kemisk Tidskrift *(Sweden)*

Talanta
Talanta *(England)*

Tech. Mitt. Krupp. Forschungsber.
Technische Mitteilungen Krupp. Forschungsberichte *(Germany)*

Tech. Mitt. Krupp. Werksber.
Technische Mittellungen Krupp. Werksberichte *(Germany)*

Tech. Ueberwach.
Technische Ueberwachung *(Germany)*

Telefunken Ztg.
Telefunken Zeitung *(Germany)*

Tellus
Tellus. A Quarterly Journal of Geophysics *(Sweden)*

Teploenergetika
Teploenergetika *(U.S.S.R.)*

Texas Rept. Biol. Med.
Texas Reports on Biology and Medicine *(U. S.)*

Tidsskr. Kjemi, Bergvesen Met.
Tidsskrift for Kjemi, Bergvesen og Metallurgi *(Norway)*

Tohoku J. Exptl. Med.
Tohoku Journal of Experimental Medicine, The *(Japan)*

Tokushima J. Exptl. Med.
Tokushima Journal of Experimental Medicine, The *(Japan)*

Tokyo Kogyo Shikensho Hokoku
Tokyo Kogyo Shikensho Hokoku (Reports of the Government Chemical Industrial Research Institute, Tokyo) *(Japan)*

Torax
Torax *(Uruguay)*

Trans. Am. Geophys. Union
Transactions of the American Geophysical Union *(U. S.)*

Trans. Am. Nucl. Soc.
Transactions of the American Nuclear Society *(U. S.)*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. A: J. Eng. Power
Transactions of the ASME (American Society of Mechanical Engineers), Series A: Journal of Engineering for Power
see *J. Eng. Power*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. B: J. Eng. Ind.
Transactions of the ASME (American Society of Mechanical Engineers), Series B: Journal of Engineering for Industry
see *J. Eng. Ind.*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. C: J. Heat Transfer
Transactions of the ASME (American Society of Mechanical Engineers), Series C: Journal of Heat Transfer
see *J. Heat Transfer*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. D: J. Basic Eng.
Transactions of the ASME (American Society of Mechanical Engineers), Series D: Journal of Basic Engineering
see *J. Basic Eng.*

Trans. ASME (Am. Soc. Mech. Engrs.), Ser. E: J. Appl. Mech.
Transactions of the ASME (American Society of Mechanical Engineers), Series E: Journal of Applied Mechanics
see *J. Appl. Mech.*

Trans. Bose Res. Inst. (Calcutta)
Transactions of the Bose Research Institute (Calcutta) *(India)*

Trans. Faraday Soc.
Transactions of the Faraday Society *(England)*

Trans. Japan Inst. Metals
Transactions of the Japan Institute of Metals (Sendai) *(Japan)*

Transplantation
Transplantation (formerly Transplantation Bulletin) *(U. S.)*

Trend Eng. Univ. Wash.
Trend in Engineering at the University of Washington *(U. S.)*

Tr. Energ. Inst., Akad. Nauk Azerb. SSR
Trudy Instituta Fiziki Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Inst. Fiz., Akad. Nauk Azerb. SSR
Trudy Instituta Fiziki, Akademii Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Tr. Inst. Fiz. Akad. Nauk Gruz. SSR
Trudy Instituta Fiziki, Akademii Nauk Gruzinskoi SSR *(Georgian S.S.R.)*

Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR
Trudy Instituta Fiziki i Astronomii, Akademiya Nauk Estonskoi SSR *(Estonian S.S.R.)*

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Trudy Instituta Yadernoi Fiziki, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tsvetn. Metal.
Tsvetnye Metally† *(U.S.S.R.)*

Tufts Folia Med.
Tufts Folia Medica *(U. S.)*

TVF (Tek. Vetenskaplig Forskning)
TVF (Teknisk-Vetenskaplig Forskning) *(Sweden)*

Uch. Zap. Leningr. Gos. Univ., Ser. Biol. Nauk
Uchenye Zapiski Leningradskogo Gosudarstvennogo Ordena Lenina Universiteta imeni A. A. Zhdanova, Seriya Biologicheskikh Nauk *(U.S.S.R.)*

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Uchenye Zapiski Leningradskogo Gosudarstvennogo Ordena Lenina Universiteta imeni A. A. Zhdanova, Seriya Matematicheskikh Nauk *(U.S.S.R.)*

Ukr. Biokhim. Zh.
Ukrainskii Biokhimichnii Zhurnal *(Ukrainian S.S.R.)*

Ukr. Fiz. Zh.
Ukrainskii Fizichnii Zhurnal *(Ukrainian S.S.R.)*

Umschau Wiss. Tech.
Umschau ueber die Fortschritte in Wissenschaft und Technik, Die *(Germany)*

Usp. Fiz. Nauk
Uspekhi Fizicheskikh Nauk† *(U.S.S.R.)*

Usp. Khim.
Uspekhi Khimii† *(U.S.S.R.)*

VDI (Ver. Deut. Ingr.) Z.
VDI (Verein Deutscher Ingenieure) Zeitschrift *(Germany)*

Verhandl. Deut. Ges. Pathol.
Verhandlungen der Deutschen Gesellschaft fuer Pathologie *(Germany)*

Vestn. Akad. Nauk SSSR
Vestnik Akademii Nauk SSSR *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Fiz. i Khim
Vestnik Leningradskogo Universiteta, Seriya Fiziki i Khimii *(U.S.S.R.)*

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Vestnik Leningradskogo Universiteta, Seriya Geologii i Geografii *(U.S.S.R.)*

Vestn. Leningr. Univ., Ser. Mat., Mekhan. i Astron.

Vestnik Leningradskogo Universiteta, Seriya Matematiki, Mekhaniki i Astronomii *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. III: Fiz. Astron.
Vestnik Moskovskogo Universiteta, Seriya III. Fiziki, Astronomii *(U.S.S.R.)*

Vestn. Rentgenol. i Radiol.
Vestnik Rentgenologii i Radiologii *(U.S.S.R.)*

Vide
Vide, Le, Technique-Applications *(France)*

Welding J. (N. Y.)
Welding Journal, The (New York) *(U. S.)*

Welding Metal Fabric.
Welding and Metal Fabrication *(England)*

Wiadomosci Chemi.
Wiadomosci Chemiczne *(Poland)*

Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturw. Reihe
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(Germany)*

Wu Li Hsueh Pao
Wu Li Hsueh Pao (Acta Physica Sinica) *(China)*

Yogyo Kyokai Shi
Yogyo Kyokai Shi (Journal of the Ceramic Association of Japan) *(Japan)*

Z. Altersforsch.
Zeitschrift fuer Altersforschung *(Germany)*

Z. Angew. Math. Phys.
Zeitschrift fuer Angewandte Mathematik und Physik *(Switzerland)*

Z. Angew. Phys.
Zeitschrift fuer Angewandte Physik *(Germany)*

Z. Anorg. Allgem. Chem.
Zeitschrift fuer Anorganische und Allgemeine Chemie *(Germany)*

Zavodsk. Lab.
Zavodskaya Laboratoriya† *(U.S.S.R.)*

Z. Biol.
Zeitschrift fuer Biologie *(Germany)*

Zentr. Allgem. Pathol. Pathol. Anat.
Zentralblatt fuer Allgemeine Pathologie und Pathologische Anatomie *(Germany)*

Z. Ges. Exptl. Med.
Zeitschrift fuer Gesamte Experimentelle Medizin Zugleich Fortsetzung der Zeitschrift fuer Experimentelle Pathologie und Therapie *(Germany)*

Z. Ges. Inn. Med. Ihre Grenzgebiete
Zeitschrift fuer die Gesamte Innere Medizine und Ihre Grenzgebiete *(Germany)*

Zh. Analit. Khim.
Zhurnal Analiticheskoi Khimii† *(U.S.S.R.)*

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Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki† *(U.S.S.R.)*

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Zhurnal Fizicheskoi Khimii† *(U.S.S.R.)*

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Zhurnal Neorganicheskoi Khimii† *(U.S.S.R.)*

Zh. Prikl. Khim.
Zhurnal Prikladnoi Khimii† *(U.S.S.R.)*

Zh. Prikl. Mekhan. i Tekhn. Fiz.
Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki *(U.S.S.R.)*

Zh. Tekhn. Fiz.
Zhurnal Tekhnicheskoi Fiziki† *(U.S.S.R.)*

Z. Klin. Med.
Zeitschrift fuer Klinische Medizin *(Germany)*

Z. Krebsforsch.
Zeitschrift fuer Krebsforschung *(Germany)*

Z. Metallk.
Zeitschrift fuer Metallkunde *(Germany)*

Z. Mikroskop.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung *(Germany)*

Z. Naturforsch., a
Zeitschrift fuer Naturforschung, Part a *(Germany)*

Z. Naturforsch., b
Zeitschrift fuer Naturforschung. Part b *(Germany)*

Z. Physik
Zeitschrift fuer Physik *(Germany)*

Z. Physik. Chem. (Frankfurt)
Zeitschrift fuer Physikalische Chemie (Frankfurt) *(Germany)*

Z. Physik. Chem. (Leipzig)
Zeitschrift fuer Physikalische Chemie (Leipzig) *(Germany)*

Z. Physiol. Chem.
Zeitschrift fuer Physiologische Chemie, Hoppe-Seyler's *(Germany)*

Z. Rheumaforsch.
Zeitschrift fuer Rheumaforschung *(Germany)*

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